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MASSACHUSETTS BAYS

1991 COMPREHENSIVE CONSERVATION

AND MANAGEMENT PLAN

GOVERNMENT DOCUMENT
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An Evolving Plan for Action

MASSACHUSETTS BAYS PROGRAM

U.S. Environmental Protection Agency

Massachusetts Executive Office of Environmental Affairs

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A MESSAGE TO THE READER

A common thread running through many sections of this plan is the need for carefully-coordinated efforts among different public agencies. Contradictory regulations, overlapping jurisdictions, and a confusing multiplicity of bureaucratic requirements make planning difficult for everyone, from public officials, to private citizens eager to enjoy or utilize marine and coastal resources. All Massachusetts Bays Program elements, from research to outreach, are designed to build our capacity for coordinated, region-wide planning and action.

Central to the success of this Program is its ability to encourage coordination and cooperation across agency lines. Different agencies within state government need to work together more effectively, and better lines of contact and coordination need to be established between and among local governments, and between local governments and state and federal offices. The Local Governance Advisory Committee envisioned in this plan is an important first step in enlivening and institutionalizing comprehensive, region-wide planning. We will also need to deepen our understanding of both the impediments to, and possibilities for, interagency coordination. By example and through grants programs, we will need to encourage and reward agency cooperation. While this region knows a long history of proud and independent institutions in the public and private sectors, the environmental challenge common to us all demands that we build institutions that help us work together more effectively and efficiently. While the challenge is great, we dare not fail to try to meet it.

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CHAPTER I. INTRODUCTION

History of Massachusetts Bays Program

The Massachusetts Bays Program (MBP) was launched in 1988 to actively address the mounting environmental threats to the health of Massachusetts and Cape Cod Bays (the Massachusetts Bays). The program is sponsored jointly by the U.S. Environmental Protection Agency (EPA), the Massachusetts Coastal Zone Management Office (CZM), and the Massachusetts Environmental Trust. Initial funding of $1.6 million from the Massachusetts Environmental Trust was the result of settlement fines from a federal suit against the Commonwealth for violations of the Clean Water Act in Boston Harbor.

In 1988, Congressman Gerry Studds, acting on behalf of the Massachusetts Congressional Delegation, drafted an amendment to the Clean Water Act, giving priority consideration to Massachusetts and Cape Cod Bays to become part of the National Estuary Program. The National Estuary Program was established to identify nationally-significant estuaries threatened by pollution, development, or overuse, and to promote the preparation of comprehensive management plans to ensure their ecological integrity. In June 1989, Governor Michael Dukakis formally submitted the nomination package for Massachusetts Bays.

In April 1990, President Bush proclaimed Massachusetts Bays an "Estuary of National Significance" and added it to the National Estuary Program. On November 13, 1990, EPA and the Commonwealth of Massachusetts signed a Management Conference Agreement which set forth work to be accomplished over the next five years.

Structure and Goals of the MBP

The first step in carrying out the estuary program was to establish a forum for open discussion and collaborative decision-making. This forum is called the Management Conference. The Management Conference oversees the activities of the estuary program and consists of representatives from appropriate federal, state, and local government agencies, regional planning agencies, various user groups, public and private education institutions, and the general public.

The Massachusetts Bays Management Conference is organized into four distinct committees: Policy Committee, Management Committee, Technical Advisory Committee, and Citizens Advisory Committee. The Policy Committee is comprised of the EPA Regional Administrator and the Massachusetts Secretary of Environmental Affairs. This committee approves the decisions of the Management Committee, the major decision-making committee in the Conference. The Management Committee receives input and advice from the Technical Advisory Committee (TAC) and the Citizens Advisory Committee (CAC).

The ultimate goal of the Massachusetts Bays Program is to institutionalize the planning process so that there are rolling five-year research and action agendas to protect, maintain, and, where necessary, restore or improve the Massachusetts Bay and Cape Cod Bay ecosystem. Work under the program will be geared to:

- Improve the habitats of living resources in Massachusetts and Cape Cod Bays.
- Protect public health by minimizing risk from environmental contaminants.
- Protect and improve water and sediment quality.
- Enhance the aesthetic quality of Massachusetts' coast and coastal waters.

- Encourage pollution prevention and other environmentally and fiscally sound methods of treatment, cleanup, and restoration.
- Improve access, educational, and appropriate recreational opportunities in and around the waters of Massachusetts and Cape Cod Bays.

To accomplish these, the Massachusetts Bays Program is developing a **Comprehensive Conservation and Management Plan** (CCMP) for Massachusetts and Cape Cod Bays. This plan will be a blueprint for coordinated action aimed at restoring and protecting water quality and the diverse natural resources of the Massachusetts Bays estuary.

Overview of CCMP

CHARTING A NEW COURSE

The Massachusetts Bays Program is charting an innovative course among the nation's seventeen National Estuary Programs by producing an early version of the Comprehensive Conservation and Management Plan during the first year of the program's federal funding. Other similar national programs have typically completed several years of scientific research before recommending a course of action. The Management Conference believes that, while much remains to be learned about Massachusetts Bays, enough is known already to begin to take action to prevent further degradation and restore the integrity of the Bays ecosystem.

This initial plan, will be revised and updated as more information about the Bays is developed through the program's research and demonstration projects. A second, more expansive, plan will be produced in 1993, followed by the full Comprehensive Conservation and Management Plan in 1995.

DEVELOPING THE MANAGEMENT PLAN

To help galvanize support and elicit ideas for developing this initial plan, the Massachusetts Bays Program hosted a "CCMP Development Workshop" in March 1991. This all-day meeting brought together over 75 environmental advocates, business leaders, citizens, and state, local, and federal officials to focus their diverse viewpoints and expertise on designing a challenging plan development process. Participants included members of the four Bays Program committees — Policy, Management, Technical Advisory, and Citizens Advisory Committees — and representatives from numerous coastal and inland communities.

Several key recommendations emerged from the workshop:

- The 1991 Plan should be addressed to all members of the Management Conference and their constituencies (the research community, state/federal managers, local governments, and the public) through a public outreach strategy.
- The Priority Problems currently identified by the Massachusetts Bays Program should be redefined in terms of "uses" of the Bays and organized in a readable, "user-friendly" format.
- The Plan should summarize what is known about the Bays and what is being done from both a scientific and management perspective.
- The Plan should contain a list or menu of options that should or could be undertaken by local governments.
- The Plan should recommend a set of **ACTIONS** to be undertaken by the constituent groups and should serve as a guide to the activities of the Management Conference (MC, TAC, CAC) between 1991 and 1993.
- The Plan should contain appendices with the supporting technical information, a glossary of terms, and a bibliography.

Following the workshop, the Management Committee formed a Working Group to oversee development of the 1991 CCMP. This Working Group met on a regular basis throughout the summer to advise program staff on the key issues and problems affecting the Bays and on appropriate actions to address these problems. Additional meetings and conversations were held with noted experts in the fields of marine ecology and public health to gain further insight on the issues and identify possible management solutions.

In framing the discussion of the major, or "priority," problems affecting the Bays, the CCMP Working Group decided that the problems should be discussed in terms of particular "uses" or "users." In this way, the general public will be better able to understand the impact of these problems and the reasons why they, as citizens, should be concerned about "toxicants" or "habitat modification," for example. Up until this time, the major problems had been defined strictly in scientific terms and within the context of a research-oriented agenda. The Working Group believed that redefining the problems in non-technical terms would not detract from the scientific nature of the problems, but will facilitate communication with the public about the important issues facing Massachusetts Bays. It will also set the stage for articulating the benefits that can be achieved by restoring and protecting the Bays. Ultimately, this will help to build the long-term public support needed for implementation of the management plan recommendations.

PLAN ORGANIZATION

This 1991 plan is organized into five chapters. Chapter I introduces the Massachusetts Bays Program and describes its evolving management plan. Chapter II provides background information on various physical, biological, and socioeconomic features of the Bays, as well as on several large-scale projects that could have significant impacts on water and sediment quality and living resources in the Bays. Chapter III examines the six **Priority Problems** identified by the program:

- Chemical contamination of water and sediments
- Bioaccumulation and effects of chemical contamination
- Pathogen contamination
- Water quality
- Habitat loss and modification
- Sea level rise

The six problems are discussed in terms of certain valued uses they impair (e.g., closure of swimming beaches due to pathogen contamination). Chapter IV, the centerpiece of the plan, contains a series of action plans that prescribe immediate and long-range actions that the Massachusetts Bays Program, various governmental agencies, and the general public can initiate to reduce pollution in Massachusetts Bays. Chapter V discusses the unfinished agenda, which includes, among other things, ongoing and proposed scientific research, public outreach and education, data management, and financing. A list of acronyms, a glossary, a bibliography, a summary of the region's governmental management framework, and a marine research agenda proposed for the Executive Office of Environmental Affairs are provided at the end of the document.

PLAN PRESENTATION

This initial plan will be widely distributed in a loose-leaf binder to underscore its development as a "living" document, subject to further review and revision. As individual pages or whole chapter sections are revised and improved, they can be incorporated without recopying the entire document. The same binder can be used for the 1993 and 1995 versions of the management plan simply by replacing outmoded material with the updated plan and title page.

CHAPTER II. BACKGROUND

GEOGRAPHIC SCOPE

The "Massachusetts Bays" region is a large, complex estuarine ecosystem located on the southwestern edge of the Gulf of Maine (Figure II-1). The region extends from Cape Ann on the North Shore to Race Point on the tip of Cape Cod, and encompasses both Massachusetts Bay and its southeast extension, Cape Cod Bay. The Bays cover an expanse of ocean 84 miles long and 24 miles wide and comprise 63,000 acres of coastal habitat. Seaward, the region extends to, and includes, Stellwagen Bank, a shallow, fertile fishing ground under active consideration for designation as a National Marine Sanctuary. Landward, the region extends to the edge of the watersheds which drain to the bays.

Although not physically part of the Massachusetts Bays estuary, six coastal communities and their watersheds on the Upper North Shore (Essex to the New Hampshire border) are also included in the scope of the Massachusetts Bays Program. These communities are included because research has indicated that the Merrimack River may be a major determinant of water quality in the Massachusetts Bays region.

Altogether, 168 Massachusetts communities are included within the scope of the Massachusetts Bays Program. Of these, 49 are coastal communities (Table II-1).

Table II-1 Coastal Communities in the MBP (Regional Designation per MCZM Office)

Upper North Shore
Salisbury
Newburyport
Newbury
Rowley
Ipswich
Essex

Lower North Shore
Rockport
Gloucester
Manchester-By-The-Sea
Beverly
Danvers
Peabody
Salem
Marblehead
Swampscott
Lynn
Nahant
Saugus

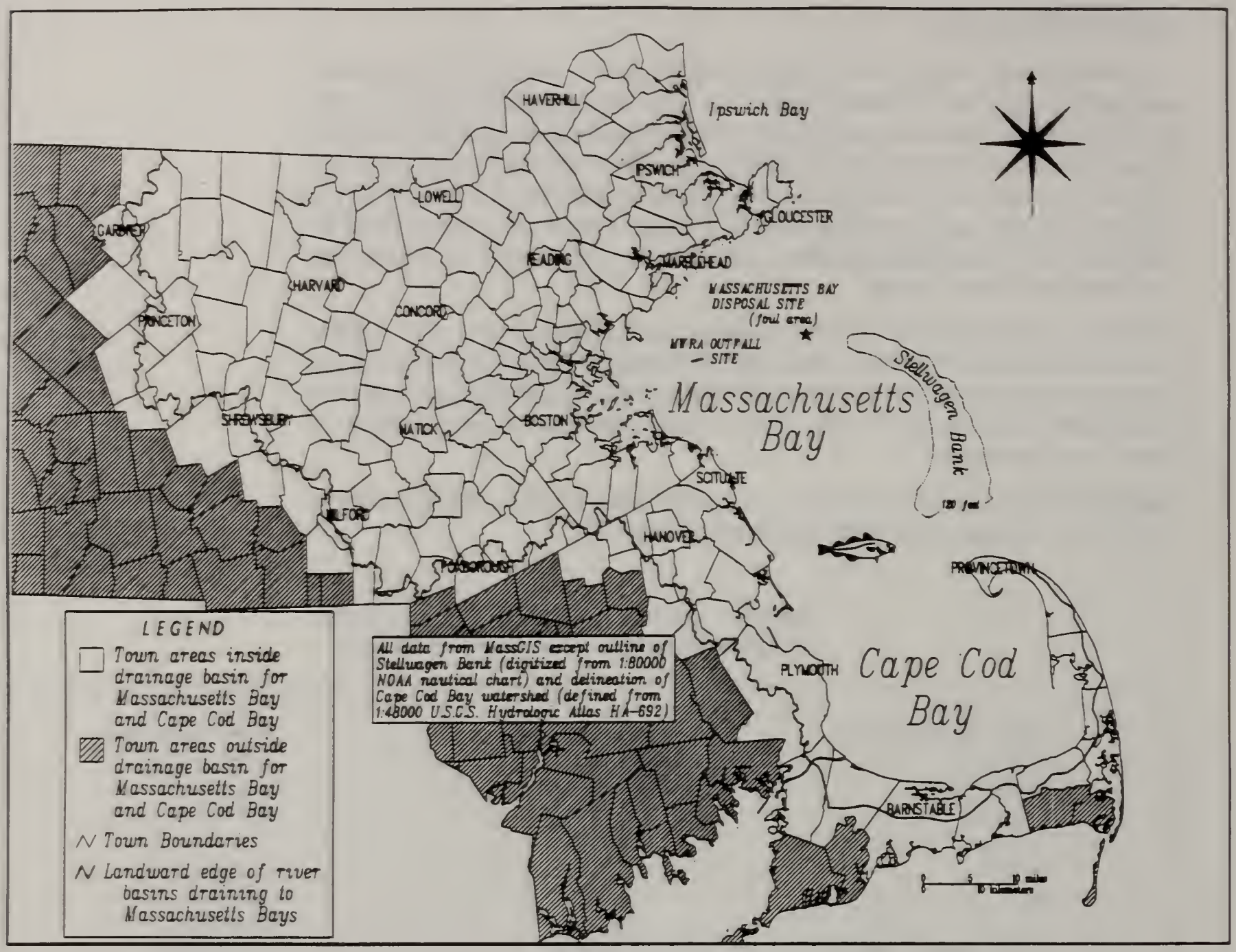
Boston Harbor
Revere
Winthrop
Chelsea
Everett
Boston
Milton
Quincy
Braintree
Weymouth
Hingham
Hull

South Shore
Cohasset
Scituate
Norwell
Hanover
Pembroke
Marshfield

Plymouth Bay
Duxbury
Kingston
Plymouth

Cape Cod
Bourne
Sandwich
Barnstable
Yarmouth
Dennis
Brewster
Orleans
Eastham
Wellfleet
Truro
Provincetown

FIGURE II-1. GEOGRAPHIC SCOPE OF THE MASSACHUSETTS BAYS REGION



PHYSICAL SETTING

Physical Features

Massachusetts Bay, exclusive of Cape Cod Bay, encompasses approximately 1,400 square miles. Average water depth ranges from less than 10 feet in Boston Harbor to over 300 feet in Stellwagen Basin. The eastern opening of the Bay is formed by Stellwagen Bank, a sandy and gravelly rise in the Bay floor that reaches to within 60 feet of the surface.

Cape Cod Bay encompasses an area of more than 600 square miles. Water depths generally range from 65 to 150 feet in the central part of the Bay, and are less than 200 feet at the deepest point. The sea floor is generally flat and featureless. The single largest topographic feature is Billingsgate Shoal, a sand spit which extends southwest from Wellfleet in 10 to 33 feet of water.

Boston Harbor covers about 45 square miles of water, coastal islands, and peninsulas. In general, it is a very shallow estuary. At mean low tide, the water depth is generally less than 10 feet, except in the shipping channels. As a result of the shallow depth and large tidal range, nearly half of the water in the harbor exits on an ebb tide. The average residence time (the time that the water remains in the harbor) is about 2 or 3 days. However, the Inner Harbor and shallow areas of the Outer Harbor are flushed much more slowly.

Boston Harbor is an unusual estuary in that nearly one half of its freshwater inflow comes from sewage effluent from the Deer Island and Nut Island Treatment facilities, and this effluent enters at the mouth, rather than the head, of the estuary. The major rivers discharging into Boston Harbor — the Charles, Mystic, Chelsea, and Neponset Rivers — have an average combined flow of about 300 cubic feet per second (cfs). By comparison, the flow of sewage effluent from the Deer Island and Nut Island facilities is about 560 cfs.

The water in Boston Harbor exhibits little stratification (that is, vertical layering due to temperature and salinity gradients). Strong tidal currents mix the harbor water, keeping stratification to a minimum.

Massachusetts Bays Systems. Massachusetts Bay, Cape Cod Bay, and Boston Harbor form an interconnected system of basins, separated from the Gulf of Maine by Stellwagen Bank. Until recently, relatively little was known about the circulation patterns within this system or about how contaminants are transported once they have entered bay waters. Coordinated studies by a consortium of scientists from the University of New Hampshire, Woods Hole Oceanographic Institution, and the University of Massachusetts/Boston are now examining bay circulation patterns and the physical and biological characteristics of bay waters. Together with ongoing research by the Massachusetts Water Resources Authority (MWRA) and the United States Geological Survey (USGS) on water circulation and accumulation of sediments, these studies will help refine our understanding of the transport and fate of pollutants in the Massachusetts Bays system.

Researchers have employed a variety of techniques to study pollutant transport in Massachusetts Bays. These techniques include: seasonal and monthly shipboard surveys; measurements of currents, pressure, and other water properties from moored stations that remain in the water; and drifter tracking studies. (Drifters are free-floating buoys released into the water and tracked by satellite to see how their destination is influenced by currents.)

Preliminary results of drifter studies suggest that the predominant direction of flow in the surface water of the bays is counterclockwise. Driven by the large volume of fresh water spilling into the bays from the Merrimack River, water from the north enters Massachusetts Bay at the tip of Cape Ann. From there it generally moves west, circles southward along the South Shore, travels through Cape Cod Bay, and exits the bay north of Provincetown.

Observation of the path of drifters points to a vigorous transport of surface water from western Massachusetts Bay through Cape Cod Bay during spring periods of high runoff. Drifter data also suggest that water tends to remain longer in Cape Cod Bay than in Massachusetts Bay.

Records of temperature and salinity, and data from a current meter, indicate that strong internal waves are generated by the tide passing over Stellwagen Bank. Currents produced by these waves may re-suspend and mix sediments containing pollutants. The flow of water along the ocean floor may also suspend and transport sediments and contaminants bound to them. A long-term current and sediment monitoring station maintained by the USGS, in cooperation with the MWRA, will help to predict the fate of contaminants deposited on the sea floor in the vicinity of the MWRA's new ocean outfall.

Drainage Basin of Massachusetts Bays

The land area in Massachusetts draining to Massachusetts and Cape Cod Bays covers over 2,500 square miles. It includes all or sections of 168 Massachusetts communities (Figure II-2) and consists of thirteen separate river basins and coastal drainage areas as established by the Massachusetts Water Resources Commission.

A significant amount of land outside Massachusetts also drains into the Massachusetts Bays region via the Merrimack River. The mainstem of the Merrimack River forms in the Lakes region of New Hampshire and flows 78 miles before entering Massachusetts. Altogether, the Merrimack Basin covers 5,010 square miles, and is the fourth largest river basin in New England. However, less than 25 percent of the watershed, or 1201 square miles, is located in Massachusetts.

Several of the rivers in the Massachusetts Bays region are actually tributaries of other rivers (for example, the Nashua, Concord, and Shawsheen Rivers all flow into the Merrimack River and are part of the Merrimack's 5,010-square mile watershed). Others, such as the Mystic, Charles, and Neponset Rivers, share a common ocean outfall (in this case, Boston Harbor). Thus, the 13 drainage areas can be consolidated into 5 larger basins — Boston Harbor, Merrimack River, North Shore, South Shore, Cape Cod — based on the geographic setting of their discharges. Together, these larger basins (listed in Table II-2) are the major source of freshwater flow into Massachusetts Bays. Excluding Cape Cod, whose flow is predominately groundwater, these areas contribute an estimated average annual riverflow of over 10,000 cfs to the Massachusetts Bays system. Eighty percent of this amount, or 8,510 cfs, is estimated to derive from the Merrimack Basin (Menzie-Cura, 1991).

FIGURE II-2. MASSACHUSETTS BAYS DRAINAGE BASIN

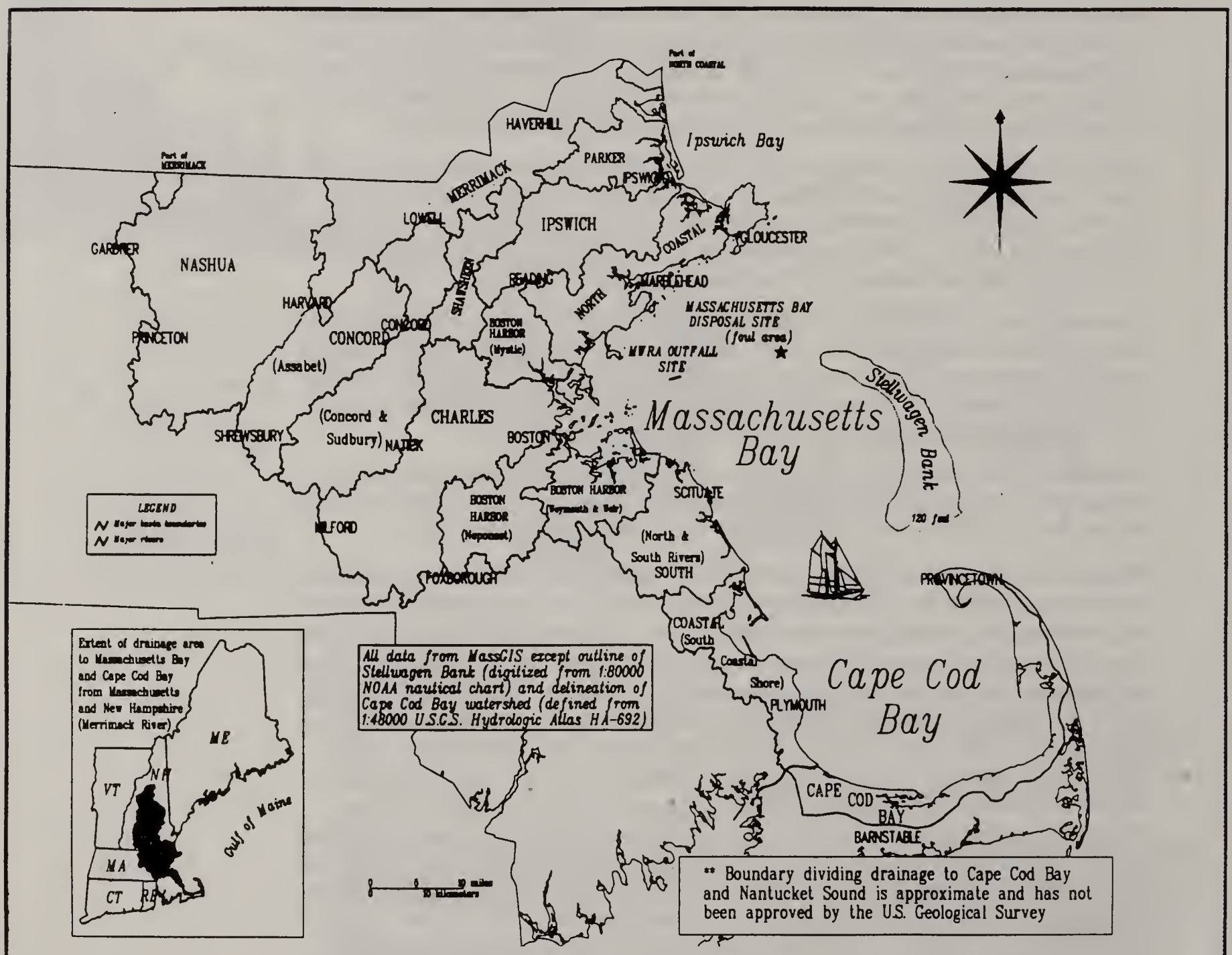


Table II-2. Coastal Drainage Areas Within the Massachusetts Bays Drainage Basin (MassGIS)

	Total Drainage Area (sq. mi.)	Estimated Annual Avg Riverflow (cfs)
Boston Harbor (Mystic, Chelsea, Charles, Neponset, Weymouth Fore, Weymouth Back, and Weir River Watersheds)	755	1,272
Merrimack River (Nashua, Concord, Shawsheen River Watersheds)	5,010	8,510
North Shore (Parker, Rowley, Ipswich, Essex, Annisquam, Bass, Danvers, Crane, Saugus, Pines)	353	533
South Shore (North, South, Green Harbor, Jones, Town Brook, Eel River, Beaver Brook Dam)	147	291
Cape Cod	45	Negligible
	6,310	10,606

Each drainage area has distinctive characteristics of size, physiography, water quality, and land use. The following sections contain brief descriptions of these characteristics in the drainage basins listed in Table II-2.

Water quality in each basin is assessed every two years by the Massachusetts Department of Environmental Protection's Division of Water Pollution Control (DWPC). Assessments of coastal basins are primarily based on data collected by the Division of Marine Fisheries (collected as part of their shellfish program), and the DWPC (as part their statewide water quality monitoring program). This assessment, published in the "Commonwealth of Massachusetts Summary of Water Quality", is the principal means by which the state, EPA, the Congress, and the public evaluate the progress made in maintaining and restoring water quality, and the extent to which problems remain.

As part of this process, the rivers, streams and marine waters of the Massachusetts Bays region are assigned use classifications according to the Massachusetts Surface Water Quality Standards. These water quality standards establish goals for a water body which reflect current and potential uses of the water. (see box) The standards also establish water quality criteria designed to protect designated uses and to provide the regulatory basis for treatment requirements to maintain or improve water quality. Each basin is assessed according to the degree to which its water quality meets the designated use criteria for the basin. The degree of support is divided into four categories: full support, partial support, non-support, and not attainable.

Across the state, the 1990 DEP rivers assessment revealed that approximately one-third of the state's assessed river miles are in support of their designated uses while two-thirds are in partial or non-support. While, on the surface these percentages may seem comparable to attainment status figures of ten years ago, in fact the analysis shows that improvement in water quality has been

Massachusetts Surface Water Quality Standards

A water quality standard defines the water quality goals of a water body by designating the use or uses to be made of the water and by setting criteria necessary to protect the uses. States adopt water quality standards to protect public health or welfare, enhance the quality of the water and to pursue the goals of the Clean Water Act to make the Nation's waters fishable and swimmable. The Massachusetts Surface Water Quality Standards (314 CMR 4.00) define six water use classes for surface waters. Three fresh water classes and three salt water classes are identified below:

Fresh Water	
Class A	Public water supply, fishable and swimmable to the extent compatible with this use
Class B	Fishable/swimmable and other compatible uses
Class C	Fishable but not swimmable
Salt Water	
Class SA	Fishable/swimmable plus open to shellfishing
Class SB	Fishable/swimmable plus restricted shellfishing
Class SC	Fishable but not swimmable

Waters must be classified A, B or SA, SB in order to comply with the federal fishable/swimmable goal. According to that goal, water quality should, wherever attainable, provide water quality for the protection and propagation of fish, shellfish and other wildlife and for recreation in and on the water. The standards should also take into consideration the use and value of a water body for public water supply, agricultural, industrial and other purposes including navigation.

The Massachusetts classification system recognizes four additional uses in addition to the national goal uses: Public Water supply in class A waters, Open Shellfishing in class SA waters, Restricted shellfishing in class SB waters, and Secondary Contact Recreation in class C and SC waters. State standards also contain an antidegradation policy designed to maintain and protect existing uses and water quality, to provide protection for higher quality waters, and to provide protection for outstanding national resource waters. In Massachusetts, standards have been established for all the state's water bodies, However, some water bodies may be segmented where appropriate, so that different standards may be applied to different segments of a water body.

These standards serve the dual purpose of establishing the water quality goals for a water body and serving as the regulatory basis for the establishment of water quality based treatment controls and strategies. The Massachusetts standards establish minimum criteria for eight water quality parameters in each use classification:

Dissolved Oxygen	Suspended Solids
Temperature	Color and Turbidity
pH	Oil and Grease
Fecal Coliform Bacteria	Taste and Odor

Acceptable levels of these parameters vary according to the designated use classification.

accomplished in a number of areas over the past decade. Certain types of pollutants, including ammonia and suspended solids, have been virtually eliminated as causes of non-attainment. This improvement is largely due to the joint federal and state Construction Grants Program that has distributed over 2.5 billion dollars in sewage treatment facilities grants to Massachusetts municipalities since 1967. As a result of this effort, municipal and industrial point sources of pollution have been significantly reduced as causes of non-attainment. However, nonpoint source pollution, especially urban runoff, remains a persistent problem and is the most prominent cause of non-attainment. Approximately 40% of the state's river miles are adversely affected by urban runoff, (including nutrients and bacterial contaminants from stormwater runoff and leaking sanitary sewers) a number that has not improved since monitoring began in 1979.

The 1990 assessment of coastal and estuarine waters reveals a different story. Marine waters in Massachusetts receive 75% of the total daily discharge of municipal wastewater in the Commonwealth, primarily in Boston Harbor. The cleanup of these sources has lagged behind the cleanup of rivers. The 1990 assessment shows that nearly 75% of the marine water assessed failed to support their designated uses (DEP 1990). This failure rate is primarily due to municipal point source and combined sewer overflow discharges of bacterial contaminants to these waters, although nonpoint sources are also perceived as a significant problem.

Boston Harbor Drainage Area

The Boston Harbor drainage area consists of the Mystic, Chelsea, Charles, Neponset, and Weymouth and Weir River Watersheds.

The Mystic River watershed lies just north of the city of Boston and is entirely urban in nature. It is formed by the confluence of the Aberjona River and Hall's Brook in Reading, and follows a southeastward course 17 miles to Boston Harbor. The middle portion of the river system is dominated by the Upper and Lower Mystic Lakes which provide hydraulic control of the river and also serve as a sediment trap. The lower portion of the river is separated from the upstream portion by the Amelia Earhart Dam, constructed in 1966 to control streamflow and halt saltwater intrusion upstream to the Lower Mystic Lake. The entire length of the Aberjona River and the Mystic River is in non-support of its class B water quality standard. Sources of contamination include stormwater runoff, combined sewer overflows, and industrial discharges along the rivers' urbanized course.

The Charles River, with a length of 80 miles, is the longest river entirely in Massachusetts. It originates in the Town of Hopkinton and meanders through a mix of rural and urban communities before emptying into Boston Harbor. Its basin is between 5 and 15 miles wide and approximately 31 miles long, and contains 20,000 acres of wetlands (about one-tenth of the total basin area) which border the river along much of its course.

The headwaters of the Charles are class A waters, and recent water quality monitoring indicates that the area is in full attainment of this standard. However, a six mile reach of the upper Charles between Milford and Bellingham is degraded by a variety of pollution sources, including combined sewer overflows, stormwater runoff, landfills, and a municipal wastewater treatment plant, and is in non-support of the class B standard. Downstream water quality improves along the 25 miles of the river between Medway and Dedham, where the class B standard is achieved. The Lower Charles River and the Charles River Basin between Watertown and Boston are heavily urbanized, and water quality is severely degraded by bacterial loadings from stormwater runoff and combined sewer overflows. Water quality in the Lower Charles does not support its class C standard.

The Neponset River begins at the Neponset Reservoir, a 272-acre man-made impoundment, and flows northeastward 29 miles to Boston Harbor. The river is gently sloping and slow-moving, in part because of several impoundments created by industries in the basin. The Neponset becomes tidal below the Walter Baker Dam in Milton. High concentrations of coliform bacteria from

stormwater runoff, septic systems, and combined sewer overflows degrade water quality in the Neponset. The entire length of the river is in non-support of its class B standard.

The Weymouth and Weir River Basin is located south of Boston on the coast, and comprises the Weymouth Fore and Weymouth Back Rivers, and numerous streams and creeks. The Weymouth Fore and Back Rivers constitute the basin's principal drainage systems flowing into Hingham Bay. Other important rivers include the Town River in the northern portion of the basin and the Weir River along the basin's southern boundary. The Weymouth Fore River from Braintree to Quincy Bay is in non-support of its class B standard. However, both the Weymouth Back and Weir Rivers are in partial or full support of class B criteria.

Merrimack River Drainage Area

The Merrimack River drainage area includes the watersheds of the Merrimack, Nashua, Concord, and Shawsheen Rivers. The Merrimack flows into Massachusetts northwest of Lowell, where the river turns abruptly eastward and flows 38 miles to Newburyport Harbor. The river has an estimated average annual discharge of over 8,500 cfs. The lower 9 miles of the Merrimack is estuarine, although the effects of the ocean tides extend 22 miles upriver to Haverhill. Several large, urban centers border the river, including Manchester and Nashua in New Hampshire, and Lowell, Lawrence, and Haverhill in Massachusetts. These cities contribute heavy pollutant loads to the river in the forms of municipal and industrial wastewater, stormwater runoff, and combined sewer overflows, which degrade the river's water quality for swimming, shellfishing, and other uses. Elevated levels of coliform bacteria and lead cause the river to be in non-support of its B and SB classifications along its entire length in Massachusetts.

North Shore Drainage Area

The North Shore drainage area consists of the Parker, Ipswich, and North Coastal watersheds.

The Parker River watershed covers 60 square miles and is sparsely developed throughout its course. The river flows 23 miles through a series of ponds and extensive upland and coastal wetlands before emptying into Plum Island Sound. It is one of the cleanest tidal rivers in the Northeast; the entire length of the river is in full support of class B and SA water quality standards.

The estuarine portion of the river below the Byfield Dam is an ecologically rich and scenic natural resource, and has been designated part of the Parker River/Essex Bay Area of Critical Environmental Concern (ACEC). Part of the Parker River/Plum Island complex is a National Wildlife Refuge which is managed to protect and enhance fish and wildlife resources and their habitats. The Parker River Refuge and adjacent Crane Wildlife Reserve are important nesting areas for piping plovers, an endangered species.

The Ipswich River Basin is a 155-square-mile watershed that encompasses all or parts of 19 Massachusetts communities. It is primarily rural-residential in character, and is used extensively for public water supply and recreational boating. The Ipswich is a slow-moving river that is subject to extreme low flows, caused in part by excessive withdrawals. Due to the water supply demands on the limited freshwater resources of the Ipswich basin, the entire freshwater reach of the Ipswich River has been classified as a "High Quality Water" and is subject to Massachusetts antidegradation water quality regulations protecting low flow rivers. All of the inland Ipswich River is in full support of class A standards. However, its expansive intertidal estuary, an area that has long supported commercial and recreational shellfishing, is now degraded by elevated levels of coliform bacteria. Coastal water quality in this estuary is in non-support of class SA standards and state shellfishing restrictions are in effect.

The North Coastal basin covers 138 square miles and extends from the Essex River on the north side of Cape Ann to Boston Harbor. It includes 16 cities and towns ranging from highly urbanized Lynn, Salem, and Beverly to rural Manchester and Essex. Major rivers include the Essex River in Essex, Annisquam River in Gloucester, Danvers River in Danvers, and Saugus and Pines Rivers in

Saugus. Contamination from stormwater runoff, combined sewer overflows, municipal wastewater treatment facilities, and industrial discharges causes each of these rivers to be in non-support of its water quality classifications. Important harbors and bays—Essex, Rockport, Gloucester, Manchester, Salem, and Lynn, to name but a few—support a broad range of commercial, recreational, and industrial activities. Rumney Marshes, a 1,000-acre saltmarsh/tidal flat complex on the southern border of this drainage area, is designated an Area of Critical Environmental Concern.

South Shore Drainage Area

The 270-square-mile South Shore drainage area is located southeast of Metropolitan Boston and includes the river basins of the North/South and Jones Rivers.

The North River basin covers 105 square miles in Scituate, Marshfield, Norwell, and Hanover and has an estimated average annual flow of 62 cfs. The North River is unique in the South Shore region due to the distance its salt marsh extends inland from the bay. Approximately 11.5 miles of this 20-mile river are tidally-influenced and support 2,300 acres of salt marsh habitat. In recognition of its uncommon aesthetic, estuarine habitat, and recreational values, the North River is designated a state Scenic River under the Massachusetts Department of Environmental Management's Scenic River Program.

1990 monitoring by DEP indicates that high coliform bacteria counts and low dissolved oxygen levels caused by stormwater runoff and septic systems occur in sections of the North and South rivers. These areas are in non-support of their water quality classifications.

The Jones River drains a total of 22 square miles in Kingston and Plymouth and has an estimated average annual flow of 44 cfs. Water quality in the upper reaches of the Jones River supports class B standards, however, high coliform bacteria levels cause non-support status of class SA standards in the Jones River estuary.

Cape Cod Drainage Area

The major features of the Cape Cod drainage area were formed by glacial action 10,000 to 12,000 years ago. Glacial moraines and outwash plains dominate the landscape, and have provided materials for the Cape's extensive beaches, dunes, and tidal flats. Interspersed throughout the sand and gravel soils are many kettle ponds, formed in deep holes created by large blocks of ice left behind when the glacier melted. Unlike the rest of the Mass Bays region, the Cape has a notable lack of long river systems. The region's glacial deposits are, in most places, very permeable. Precipitation easily infiltrates these soils instead of flowing over the surface to form rivers. The longest river — the Herring River in Mashpee (outside of the Mass Bays study area) — is only six miles long. The combined length of all Cape rivers is less than 50 miles.

As a consequence of the Cape's highly permeable glacial soils, groundwater is the major vehicle for freshwater flow into Cape Cod Bay. The significance of groundwater flow to near coastal waters on the Cape was demonstrated by the Buzzards Bay Project, which found that the eastern shore of the Buzzards Bay drainage basin (from the Cape Cod Canal to Woods Hole) was drained primarily by groundwater. The Buzzards Bay Project also found that in Buttermilk Bay, 74 percent of the nitrogen entering the embayment was conveyed by groundwater.

Stormwater runoff and water-based pollution sources such as marinas and boats contribute pollutants to the Cape's waters. High coliform bacteria counts result in shellfish bed closures and cause many of the Cape's rivers, streams, and coastal waters to be in non-support of their class SA water quality standards.

The Cape Cod drainage basin supports extensive coastal habitat and includes seven of the state's 12 designated Areas of Critical Environmental Concern. Three of these ACECs — Sandy Neck, Inner Cape Cod Bay, and Wellfleet Harbor — are within the Massachusetts Bays study area.

POPULATION

The Massachusetts Bays drainage basin (excluding the New Hampshire portion of the Merrimack River) covers all or parts of 168 Massachusetts communities and contains an estimated 1990 resident population of 3.8 million. This population represents a modest increase of 3.9 percent over the estimated 1980 population, and only a 2.7 percent increase over the 1970 figure. Thus, while several subregions and a number of individual communities within the drainage basin experienced rapid population growth during the 20-year period, the population of the basin as a whole has remained relatively stable (Table II-3).

Table II-3. Estimated Population in the Massachusetts Bays Drainage Basin, 1970-1990

1970	1980	1990	%Change 1970-1990
3,712,355	3,667,800	3,811,687	2.67%

Most of the growth within the coastal zone of Massachusetts Bays occurred on Cape Cod and the South Shore. The Cape's population nearly doubled between 1970 and 1990 — from 68,980 to 133,907 — as all eleven communities experienced large population increases. Barnstable alone grew by 21,000. The South Shore's coastal population grew by over 50 percent, with the Town of Plymouth accounting for over half (57 percent) of the increase. The population of the Upper North Shore grew by 20 percent, while the Lower North Shore and Boston Harbor regions experienced population losses (3.8 percent and 8.2 percent, respectively).

Table II-4 summarizes the 1970-1990 population changes for the coastal communities in the Massachusetts Bays region.

Table II-4. Coastal Community Population Changes, 1970-1990

REGION/COMMUNITY	1970 Population	1980 Population	1990 Population	Change 1970-1990
UPPER NORTH SHORE	4,179	5,973	6,882	64.68%
Salisbury	15,807	15,900	16,317	3.23%
Newburyport	3,804	4,529	5,623	47.82%
Newbury	3,040	3,867	4,452	46.45%
Rowley	10,750	11,158	11,873	10.45%
Ipswich	2,670	2,998	3,260	22.10%
Essex	40,250	44,425	48,407	20.27%
LOWER NORTH SHORE	5,636	6,345	7,482	32.75%
Rockport	27,941	27,768	28,716	2.77%
Gloucester	5,151	5,424	5,286	2.62%
Manchester-By-The-Sea	38,348	37,655	38,195	-0.40%
Beverly	26,151	24,100	24,174	-7.56%
Danvers	48,080	45,976	47,039	-2.17%
Peabody	40,556	38,220	38,091	-6.08%
Salem	21,295	20,126	19,971	6.22%
Marblehead	13,578	13,837	13,650	0.53%
Swampscott	90,294	78,471	81,245	-10.02%
Lynn	4,119	3,947	3,828	-7.06%
Nahant	25,110	24,746	25,549	1.75%
Saugus	346,259	326,615	333,226	-3.76%
BOSTON HARBOR	43,159	42,423	42,786	-0.86%
Revere	20,335	19,294	18,127	-10.86%
Winthrop	30,626	25,431	28,710	-6.26%
Chelsea	42,485	37,195	35,701	-15.97%
Everett	641,071	562,994	574,283	-10.42%
Boston	27,190	25,860	25,725	-5.39%
Milton	87,966	84,743	84,985	-3.39%
Quincy	35,050	36,337	33,836	-3.46%
Braintree	54,610	55,601	54,063	-1.00%
Weymouth	18,845	20,339	19,821	5.18%
Hingham	9,961	9,714	10,466	5.07%
Hull	1,011,298	919,931	928,503	-8.19%
SOUTH SHORE	6,954	7,174	7,075	1.74%
Cohasset	16,973	17,317	16,786	-1.10%
Scituate	7,796	9,182	9,279	19.02%
Norwell	11,193	13,487	14,544	29.94%
Pembroke	15,223	20,916	21,531	41.44%
Marshfield	7,636	11,807	13,895	81.97%
Duxbury	5,999	7,362	9,045	50.78%
Kingston	18,606	35,913	45,608	145.13%
Plymouth	90,380	123,158	137,763	52.43%
CAPE COD	12,636	13,874	16,064	27.13%
Bourne	5,239	8,727	15,489	195.65%
Sandwich	19,842	30,898	40,949	106.38%
Barnstable	12,033	18,449	21,174	75.97%
Yarmouth	6,454	12,360	13,864	114.81%
Dennis	1,790	5,226	8,440	371.51%
Brewster	3,055	6,306	5,838	91.10%
Orleans	2,043	3,472	4,462	118.40%
Eastham	1,743	2,209	2,493	43.03%
Wellfleet	1,234	1,486	1,573	27.47%
Truro	2,911	3,536	3,561	22.33%
Provincetown	68,980	108,543	133,907	94.12%
TOTALS	1,557,167	1,520,672	1,581,806%	1.58%

LAND USE

Land use varies widely in the Massachusetts portion of the Massachusetts Bays region, ranging from high-density urban centers around Metropolitan Boston to low density, rural-residential communities on the North and South Shores. A profile of percent change in urban versus non-urban land uses in the five drainage basin groupings between 1971 and 1985 is presented in Table II-5. The information was developed from MassGIS data and consists of five categories of urban environment and four categories of non-urban environment. It should be noted that the compilation and analysis of this MassGIS land use data is preliminary. Further analysis is underway.

General trends indicate that significant land development occurred throughout much of the Massachusetts Bays region between 1970 and the mid-1980's, spurred by the economic boom of that period. Across the region, the percentages of land in industrial, residential, and commercial uses showed significant increases. Between 1971 and 1985, the amount of land in industrial use increased by 39.9 percent; the amount of land in residential and commercial uses increased by 15 percent and 19.7 respectively. The total amount of developed land across the region increased by 15.6 percent. Conversely, the region experienced decreases in forest land (7.2 percent), land in agricultural use (7.1 percent), undeveloped open land (3.3 percent) and wetlands (1.9 percent). The figures cited for percent-change in wetlands area are unreliable due to differences in photographic source material used in the interpretation. A MassGIS representative indicated that the higher resolution of 1985 photography resulted in apparent increases in wetland area. This higher resolution allowed the delineation of more wetland area in 1985 than in 1971. Forested wetlands, however, are not explicitly delineated in either 1971 or 1985 and are included in the forest category.

A number of the communities in the region experienced unprecedented rates of growth that resulted in dramatic and irretrievable losses of land formerly classified as forest, farm, or wetland (see Table II-6). Nowhere has this phenomenon been more starkly evident than on Cape Cod, where the year-round population ballooned by over 76 percent between 1970 and 1986. According to land use data compiled by the University of Massachusetts, over 35,500 acres of forest and agricultural land on Cape Cod were lost to development between 1970 and 1990. The majority of this land (over 29,000 acres) was developed for residential purposes. Commercial and industrial growth consumed another 2,700 acres. All told, development now covers more than 33% of the Cape's total land area (Cape Cod Commission, 1991).

Of the five towns in the Commonwealth that are estimated to have had the highest rates of land consumption during the first half of the 1980's, four are communities on Cape Cod, including three in the Massachusetts Bays region. Nine other Massachusetts Bays communities are among the 15 highest land-consuming areas in the state — four in the Merrimack Valley, two in the suburbs south and west of Boston, and one on the South Shore. Altogether, an estimated 13,365 acres of land were consumed in the 11 Massachusetts Bays region communities identified in Table II-6. This is the equivalent of 21 square miles, or an area the size of the Towns of Dennis or Wellfleet on Cape Cod.

Table II-5. Land Use Change in the Massachusetts Bays Drainage Basin, 1971-1985 (shown in square miles)

	Merrimack			North Shore			Boston Harbor			South Shore			Cape Cod			Mass. Bays Total		
Category	1971	1985	% Change	1971	1985	% Change	1971	1985	% Change	1971	1985	% Change	1971	1985	% Change	1971	1985	% Change
Developed Residential	198.4	236.9	19.4%	89.1	100.5	12.8%	201.8	217.4	7.7%	44.4	52.9	19.1%	16.3	25.0	53.4%	550.0	632.7	15.0%
Commercial	12.9	16.8	30.2%	6.0	7.3	21.7%	17.9	19.7	10.1%	2.1	2.7	28.6%	1.2	1.5	25.0%	40.1	48.0	19.7%
Industrial	11.9	17.9	50.4%	3.3	5.0	51.5%	14.6	18.5	26.7%	0.8	1.4	75.0%	0.2	0.3	50.0%	30.8	43.1	39.9%
Transportation	17.0	19.9	17.1%	6.0	6.4	6.7%	16.7	17.4	4.2%	2.9	3.0	3.4%	2.3	2.3	0.0%	44.9	49.0	9.1%
Other	14.4	17.1	18.8%	6.3	6.3	0.0%	14.4	13.8	-4.2%	2.8	3.2	13.2%	0.7	0.8	14.3%	38.6	41.2	6.7%
TOTAL	254.6	308.6	21.2%	110.7	125.5	13.4%	265.4	286.8	8.1%	53.0	63.2	19.2%	20.7	29.9	44.4%	704.4	814.0	15.6%
Agriculture	116.5	108.2	-7.1%	25.2	23.7	-6.0%	23.6	20.8	-11.8%	9.6	9.7	1.7%	1.7	1.6	-5.9%	176.5	164.1	-7.1%
Undeveloped Open Land	59.0	56.2	-4.8%	21.7	21.1	-2.7%	40.0	38.7	-3.3%	9.1	9.5	4.8%	16.8	16.3	-3.0%	146.6	141.8	-3.3%
Participation & Water-Based Recreation	9.4	9.8	4.3%	5.9	5.9	-0.4%	9.0	9.6	6.1%	2.5	2.5	0.0%	2.2	2.4	9.1%	29.0	30.1	3.9%
Forest	672.1	628.0	-6.6%	195.6	183.2	-6.3%	220.6	203.2	-7.9%	142.7	131.9	-7.6%	72.9	64.1	-12.1%	1303.9	1210.4	-7.2%
Wetland	46.6	44.6	-4.2%	41.3	41.0	-0.8%	28.6	28.3	-1.2%	14.9	14.8	-1.1%	17.3	17.3	0.0%	148.7	145.9	-1.9%
Water	44.2	45.1	2.2%	7.7	7.8	1.8%	15.4	15.0	-2.8%	7.8	8.0	2.6%	3.4	3.4	0.0%	78.5	79.4	1.1%
BASIN TOTALS	1202.3	1200.6		408.1	408.2		602.6	602.3		239.6	239.6		135.0	135.0		2587.6	2585.6	

Table II-6. Massachusetts Communities With Highest Estimated Land Consumption (acres) 1981-1986

Rank	Community	Geographic Area	Housing Acres Consumed	Business Acres Consumed	Total Acres Consumed
1	Mashpee	Cape Cod	2,178	37	2,215
*2	Brewster	Cape Cod	1,795	34	1,829
*3	Barnstable	Cape Cod	1,331	217	1,548
*4	Sandwich	Cape Cod	1,378	48	1,426
*5	Ashland	West of Boston	1,298	8	1,306
6	Mansfield	Southwest of Boston	724	333	1,057
7	Edgartown	Martha's Vineyard	1,014	24	1,038
*8	Chelmsford	Merrimack Valley	566	392	958
9	Falmouth	Cape Cod	832	119	951
*10	Franklin	Southwest of Boston	912	28	940
*11	Tewksbury	Merrimack Valley	850	69	919
12	Nantucket	Nantucket	815	76	891
*13	Plymouth	South Shore	644	172	816
*14	Tyngsborough	Merrimack Valley	758	53	811
*15	Andover	Merrimack Valley	412	392	804
		Total	**15,507**	**2,002**	**17,509**

* Communities located in the Massachusetts Bays Region

(Modified from Greenbaum and O'Donnell (1987), based on Herr and Robinson (1987)

COMMERCIAL AND RECREATIONAL FISHERIES RESOURCES

Shellfish Resources

The inshore shellfishery of the Massachusetts Bays region is a major component of the marine fishery resource of Massachusetts and an integral part of the state's coastal heritage. In 1989, over 27,000 shellfish permits were issued statewide, producing over 313,000 bushels of shellfish valued at over $14 million. Harvested species included soft-shell clams, quahogs, oysters, bay scallops, blue mussels, and, to a lesser extent, conchs and razor clams (Table II-7).

Table II-7. Massachusetts Shellfish Statistics
Based on Local Shellfish Officer Reports *

Number of Permits Issued by Cities and Towns

Total Family (Recreational) Permits	19,835
Resident Family Permits	17,467
Non-resident Family Permits	2,368
Commercial Permits	1,995
Senior Citizen Permits	5,752
Total of All Permits	27,582

Shellfish Harvest (in bushels)

Species	Recreational	Commercial
Quahog	14,063	39,625
Mixed	6,116	11,787
Chowder	3,731	9,740
Cherrystone	9,669	23,496
Littleneck	17,732	** 70,893
Soft Shell Clam	1,718	1,367
Oyster	4,223	56,163
Bay Scallop	111	1,445
Razor Clam	0	0
Surf Clam	1,229	30,269
Mussel	117	9,628
Conch		
Total Bushels	58,708	254,413

* Towns not reporting in 1989 that reported in 1988: Duxbury, Gay Head, Mattapoisett, Wellfleet

** Commercial soft shell clams includes moderately-contaminated clams processed at the Division's Shellfish Purification Plant

Finfish Resources

In 1990, the Massachusetts commercial finfishing industry ranked 14th nationally in total volume of landings (269 million pounds), with a value of $147.7 million (NMFS, personal communication). Among the New England states, Massachusetts ranked first in both volume and value of finfish landings. The Port of Gloucester ranked 10th among the nation's ports in total volume of fishery landings (126 million pounds, including shellfish).

Approximately 46 species of edible fish, shellfish, and crustaceans are landed by Massachusetts commercial fishermen in over 50 ports, more than half of which are located along the Massachusetts and Cape Cod Bays coastlines. The most important species include sea scallop, cod, lobster, yellowtail flounder, haddock, winter flounder, bluefin tuna, and swordfish. Gloucester and Boston are the major fishing ports along Massachusetts Bay, although smaller ports, such as Scituate, Plymouth, and Provincetown, also have significant landings of fish and shellfish. These ports support day-boat trips to inshore fishing grounds, generally within 12 miles of the coast. The vessels participating in these fisheries are usually less than 60 feet long and include a large number of boats that fish exclusively for lobster.

Sportfishing for species such as striped bass, winter flounder, and bluefish is also a major activity in Massachusetts Bays. The abundance of these species, and the numerous services available to anglers, attract thousands of sportfishermen each year to the region's shores. This activity has a significant beneficial impact on the area's economy. Many small businesses benefit from sportfishing-based support services, such as motor fuel sales, small boat maintenance and repair, boat yard storage and loading ramps, food, lodging, and bait and tackle shops. In addition, local industries that manufacture durable goods, such as sportfishing boats, benefit from sportfishing activities in the region. In 1987, saltwater anglers spent over $800 million in Massachusetts.

Lobster Resources

Another important component of the Massachusetts Bays fisheries resources is the American Lobster. The Bays' lobster fishery is the most economically important single-species fishery conducted within territorial waters, with annual landings of more than $40,000,000. In 1989, inshore commercial lobstermen landed 14,610,078 pounds; another 392,252 pounds were harvested by recreational lobster fishermen. The state's total annual landings rank second in the nation, following the state of Maine.

Essex County ranked first in total pounds of lobster landed in 1989, followed by Plymouth County and Suffolk County. Boston ranked as the number one port in total pounds, followed by Gloucester, Plymouth and Beverly. The North Shore communities in Essex County also had the highest number of active commercial fishermen. (DMF, 1989)

1989 DMF Lobster Fishery Statistics indicate that the number of active lobster fishermen in Massachusetts has declined in recent years. The total number of commercial licenses issued by DMF fell from a high of 2,772 in 1987 to 2,638 in 1989. However, the statistics also reveal that, despite the drop in the number of fishermen, lobster landings have increased slightly over the past five years. Between 1985 and 1989, commercial landings rose 2.9%, from 14,203,083 pounds to 14,610,028 pounds (DMF, 1989).

HABITATS AND OTHER LIVING RESOURCES

Massachusetts and Cape Cod Bays contain a rich variety of estuarine and marine habitats, ranging from shallow tidal creeks and flat, sandy beaches to rocky headlands and deep ocean waters. Together, they provide essential food, cover, migratory corridors, and breeding and nursery areas for a broad assortment of coastal and marine organisms, including commercially-important fish and shellfish and a variety of waterbirds, including seabirds, shorebirds, and wading birds. A variety of coastal habitats are also used by raptors, including the endangered peregrine falcon and bald eagle. Rivers and streams in the coastal zone support fish, including recreationally-important species such as trout, bass, perch, and pickerel, as well as anadromous fish. Coastal upland habitats (such as islands, fields, shrublands, and forests) support a variety of wildlife species, including resident mammals as well as neotropical migrants such as warblers, which add to the diversity of living resources in the Massachusetts Bays Region.

Salt Marshes

There are more than 36,000 acres of salt marsh habitat in the Massachusetts Bays region. North Shore communities account for more than 18,000 acres (almost 50 percent of the total), followed by Cape Cod (12,600 acres). Other numerous, important pocket marshes, remnants of previously larger marshes, abound throughout the area, including 5,700 acres on the South Shore and approximately 2,000 acres in the Boston Harbor region.

Salt marshes are flat, open, grassy areas bordering tidal waters. They are typically found in sites that are protected from the high energy of the open coast, such as estuaries, salt ponds, or behind barrier beaches. Historically viewed as wasteland, salt marshes and tidal streams are now valued as important resources that provide food and habitat for wildlife, protect the coastal zone from floods, and absorb certain water-borne contaminants. In fact, the salt marsh environment is one

of the most productive ecosystems in the world, even exceeding most types of agricultural land. Many economically and environmentally important fish and shellfish species inhabit its tidal creeks for at least part of their life cycle. Important species in the salt marshes of the Massachusetts Bays region include winter flounder, mummichogs, eels, sticklebacks, menhaden, bluefish, striped bass, and herring. Salt marshes are also an important shellfish habitat. Soft-shell clams burrow in the intertidal mud flats bordering salt marsh creeks, and juvenile lobsters frequently colonize chunks of salt marsh peat that slump into the tidal creeks.

The organic matter produced by salt marsh grasses forms the basis of the food chain that supports a broad assemblage of salt marsh finfish and shellfish. Plant detritus falling into and conveyed by the marsh creeks is consumed by a variety of invertebrates, which in turn are consumed by fish, birds, and mammals. Thus, the salt marsh habitat is an essential ingredient in the diversity and productivity of living resources within the Massachusetts Bays estuarine environment.

Salt marshes also add greatly to the aesthetic quality of the coastal landscape, providing recreational enjoyment through fishing, shellfishing, waterfowling, and nature appreciation in all seasons.

Tidal Flats

Tidal flats, also known as clam flats, are shallow, intertidal areas in estuaries and quiet bays, and behind barrier beaches. Their sand-mud substrate does not support large plants, but it provides important habitat for microscopic algae and vast numbers of clams, quahogs, and marine worms as well as a foraging area for migratory shorebirds, wading birds, waterfowl, and raptors.

There are over 33,000 acres of tidal flats in the Massachusetts Bays region. Nearly half of this amount (15,218 acres) is on Cape Cod, and the remainder is distributed throughout the area.

Eelgrass Beds

Eelgrass beds serve several critical functions in the estuarine environment. They provide important habitat for many species of finfish, shellfish, geese, and ducks. They reduce turbidity and improve water quality by filtering suspended solids from the water column and serving as a baffle to moving sand. They contribute to the production of organic matter which is an essential component of nearshore food webs.

Commercially and recreationally valuable finfish and shellfish use the cover of eelgrass as their primary nursery and feeding grounds, and as refuge from predators. Juvenile winter flounder have been found to prefer muddy areas bordered by eelgrass, and bay scallops depend on eelgrass beds as adults. Some researchers have suggested a possible link between the near-extinction of Massachusetts scallops in the 1930's and the destruction of many Atlantic coast eelgrass beds by "wasting disease," a marine slime mold, but thus far this link is only conjecture.

Although some aerial surveys and on-site investigations have been conducted, the overall status of eelgrass beds in the Massachusetts Bays region is largely undetermined. Areas known to contain eelgrass include: Gloucester Harbor off Niles Beach, Stage Fort, and Raymonds Beach; the entrance of Manchester Harbor; West Beach in Beverly Farms; Broad Sound off Little Nahant; Point Shirley (the ocean side of Deer Island); Plymouth and Duxbury Harbors; and Cape Cod from Barnstable to Harwich. Eelgrass also has been reported in Boston Harbor near the public boat landing in Winthrop and off Wollaston Beach, but no comprehensive surveys have been undertaken to confirm this. Recent surveys north of Boston indicate that eelgrass is now reduced in or absent from a number of North Shore estuaries and embayments in which it once occurred: the Merrimack River estuary, Essex Bay, Annisquam River in Gloucester, and Salem and Marblehead Harbors.

Among the reasons cited for eelgrass decline are wasting disease, polluted sewer and stormwater discharges, local dredge and fill projects, and heavy boat traffic in shallow waters. Of growing concern are the subtle, incremental threats from nonpoint sources of pollution, such as urban runoff, landfills, and septic systems. Eelgrass meadows in coastal ponds on Cape Cod have been replaced by undesirable macroalgal communities in areas where excess nitrogen loading has occurred as a result of nonpoint source pollution from development in the watershed (Valiela and Costa, 1988).

Barrier Beaches

Most barrier beaches are long, narrow strips of coastal dune and beach that are formed from sand and gravel transported by waves. They typically begin as sand spits that grow out from and run parallel to the shore. The front of the barrier beach faces the open ocean and is extremely unstable, absorbing the brunt of storm waves and tides. The inland side borders an estuary or marsh system. Barrier beaches provide critical nesting habitat for some of the Commonwealth's rare coastal birds, such as the piping plover and the roseate tern. Marine and anadromous fish use the sheltered, brackish waters behind barrier islands as feeding and spawning areas. These areas also are important feeding and resting areas for wading birds, shorebirds, and waterfowl, and serve as important wintering habitat for waterfowl.

There are more than 10,000 acres of barrier beaches along the Massachusetts Bays coast. Outstanding examples that have not been lost to development include Sandy Neck in Barnstable and the Provincelands (Provincetown) on Cape Cod; and Salisbury Beach and Plum Island on the North Shore.

Rocky Headlands and Intertidal Shores

Rocky shore ecosystems occur along numerous stretches of the Massachusetts Bays coastline. In some places they have developed on the exposed faces of rocky headlands, such as those of Rockport, Gloucester, and other North Shore communities. In other places they have developed on boulders and cobbles derived from glacial moraine deposits along the South Shore and Cape Cod. These habitats are exposed to great physical stress, pounded by waves and dried by wind, sun, and summer heat. Despite these conditions, the rocky shore habitat supports a diversity of plant and animal life, including cyanobacteria (formerly blue-green algae), algae, crustaceans (barnacles, crabs, lobsters, shrimp), starfish, mollusks (snails and mussels), and certain finfish, like tautog.

Inshore/Nearshore Waters

The inshore/nearshore waters of the Massachusetts Bays region are the chief breeding ground for many commercially-important fish species, and are a feeding ground for numerous marine birds and marine mammals. The Atlantic white-sided dolphin and the harbor porpoise are commonly sighted in Bays waters. The harbor seal and grey seal are also present, although the latter species is infrequently observed. Inshore/nearshore waters are also the primary habitat for the Commonwealth's lobster population (DMF, 1985). Commercial fish species include bluefin tuna, haddock, pollack, winter flounder, Atlantic herring, and Atlantic cod.

Offshore Feeding Grounds

Several offshore areas between Cape Cod and Cape Ann are important feeding grounds for whales. The best known area, Stellwagen Bank, is a critical shallow-water feeding ground for many of the North Atlantic's last remaining Northern right whales, the rarest of the world's great whales. Other species of whales, including humpback whales, finback whales, and minke whales, also use Stellwagen Bank as a feeding ground. In recent years, this area has been habitat for a large population of American sand lance, a primary prey species of many birds, fish and marine mammals.

Islands

Massachusetts Bays contain numerous islands, most of which are highly developed. However, there are approximately 45 islands with varied habitats, including herbaceous, shrub, and forested habitats that support nesting populations of migratory seabirds and wading birds, including terns, gulls, egrets, and herons. These habitats also support significant populations of birds that migrate through the coastal zone. Outstanding examples of islands along the Massachusetts Bays coast that have not been irretrievably lost to development include Thatcher Island and Milk Island off the North Shore.

Anadromous Fish Runs

Massachusetts contains approximately 150 rivers and streams that support the migration and spawning of anadromous fish (P. Brady, DMF, personal communication). These are fish species which hatch in fresh water, migrate seaward where they spend much of their adult lives, then return upriver to spawn. They include American shad, alewife, rainbow smelt, sea run brook trout, blueback herring and Atlantic salmon (Merrimack River). Historically, most of the rivers and streams entering Massachusetts Bays supported viable anadromous fish populations, but pollution, overfishing, and construction of impassable dams have combined to reduce the number of anadromous fish runs.

Table II-8 shows the amount of acreage and distribution of three coastal habitats — tidal flats, salt marshes and barrier beaches — in the Massachusetts Bays region.

Table II-8. Acreages of Coastal Habitats in MA Bays (Hankin, 1985)

Region/Community	Tidal Flats	Salt Marshes	Barrier Beaches
UPPER NORTH SHORE			
Salisbury	115.5	2,535.5	345.3
Newburyport	690.7	179.9	166.1
Newbury	431.6	4,669.5	606.6
Rowley	211.2	1,983.3	186.0
Ipswich	1,539.9	4,376.0	1,333.3
Essex	512.5	2,188.3	0.0
	3,501.4	15,932.5	2,637.3
LOWER NORTH SHORE			
Rockport	74.7	48.2	35.6
Gloucester	1,412.9	1,188.1	171.6
Manchester-By-The-Sea	127.6	19.1	10.7
Beverly	303.9	29.5	1.5
Danvers	96.5	34.9	0.0
Peabody	0.0	9.0	0.0
Salem	317.0	30.8	0.0
Marblehead	112.2	6.0	14.6
Swampscott	0.0	0.0	4.1
Lynn	49.3	17.6	0.0
Nahant	0.0	32.8	80.0
Saugus	92.2	670.4	0.0
	2,586.3	2,086.4	318.1
BOSTON HARBOR			
Revere	183.5	490.6	151.2
Winthrop	295.8	102.7	14.9
Chelsea	29.5	2.0	0.0
Everett	0.0	0.0	0.0
Boston	878.5	391.7	28.4
Milton	0.0	147.9	0.0
Quincy	1,459.6	587.2	71.4
Braintree	37.7	6.0	0.0
Weymouth	549.7	157.2	4.2
Hingham	614.5	89.2	4.8
Hull	511.3	89.6	599.0
	4,559.8	2,064.1	873.9
SOUTH SHORE			
Cohasset	287.6	158.4	20.1
Scituate	621.8	1,245.2	323.1
Norwell	0.0	462.5	0.0
Pembroke	0.0	145.4	0.0
Marshfield	172.9	2,311.9	232.1
Duxbury	3,436.8	1,093.0	247.7
Kingston	905.0	83.8	0.0
Plymouth	2,109.5	290.5	348.0
	7,533.6	5,790.7	1,171.0
CAPE COD			
Bourne	201.8	297.7	75.0
Sandwich	7.4	1,128.2	259.5
Barnstable	2,646.4	4,085.1	1,841.7
Yarmouth	1,542.1	1,230.0	212.5
Dennis	1,002.1	1,138.9	232.0
Brewster	2,367.7	420.5	53.0
Orleans	2,441.1	1,377.0	532.1
Eastham	2,817.9	1,376.2	224.7
Wellfleet	1,893.7	1,039.5	164.4
Truro	92.5	233.1	1,001.1
Provincetown	205.4	332.6	725.8
	15,218.1	12,658.8	5,321.8
TOTALS	**33,399.2**	**38,532.5**	**10,322.1**

BEACHES AND RECREATIONAL RESOURCES

The coastal communities of the Massachusetts Bays region contain over 100 municipal, state, and federal public beaches. These rank among the region's most important economic and recreational resources, and are frequented by tens of thousands of bathers, boaters, and fishermen annually.

Table II-9 lists 20 national and state parks, wildlife refuges, forests and historical sites along the Massachusetts Bays coast. Many are extremely popular. For example, the Boston Harbor Islands State Park receives more than 220,000 visitors per year.

Table II-9. Representative Parks, Wildlife Refuges, Forests, and Historic Sites in the Massachusetts Bays Region

Site	Location
Salisbury Beach State Reservation	Salisbury
Parker River National Wildlife Refuge	Newbury
Greenwood Farm Salt Marsh	Ipswich
Crane Wildlife Refuge	Ipswich
Crane Memorial Reservation	Ipswich
Halibut State Park	Rockport
Halibut Point State Park	Rockport
Thatcher Island National Wildlife Refuge	Rockport
Knight Wildlife Sanctuary	Rockport
Salem Maritime National Historic Site	Salem
Misery Islands Reservation	Salem
Crowninshield Island	Marblehead
Lynn Heritage State Park	Lynn
Saugus Iron Works National Historic Site	Saugus
Belle Isle Marsh Reservation	Saugus
Boston National Historic Park	Boston
Boston Harbor Islands State Park	Boston
Webb State Park	Weymouth
Worlds End Reservation	Hingham
Wompatuck State Park	Hingham
Cushing Memorial State Park	Scituate
Myles Standish Monument State Reservation	Duxbury
Kingston State Forest	Kingston
Holmes Reservation	Plymouth
Plymouth Rock State Park	Plymouth
Myles Standish State Forest	South Carver
Scusset Beach State Reservation	Sandwich
Shawme-Crowell State Forest	Sandwich
Nickerson State Forest	Brewster
Brewster State Forest	Brewster
Cape Cod National Seashore	Outer Cape Cod

The Massachusetts Geographic Information System (MassGIS) is compiling a database and datalayer map of all open space land protected by municipal, state, and federal governments in Massachusetts. The list will include all land owned and protected by three private non-profit organizations — the Massachusetts Audubon Society, the Nature Conservancy, and the Trustees of Reservations. When completed, the system will allow users to locate protected areas statewide, including protected open space along the coast. (A pilot project was recently completed which lists and maps state and federal lands and all privately and municipally protected open space in Essex County.)

In addition to the state and national parks listed above, there are many municipal parks in the communities bordering the Massachusetts Bays area. These municipal sites offer a range of active and passive recreational opportunities, including swimming, boating, fishing, team sports, picnic sites, and childrens' play areas.

For marine boating enthusiasts, there are 18 state-supported public boat ramps in the Massachusetts Bays region (Table II-10).

Table II-10. State-Supported Public Boat-Launching Sites Along the Massachusetts Bays Coast

Location	Community
Black Rock Creek	Salisbury
Cashman Park	Newburyport
Parker River	Newbury
Lanes Cove	Gloucester
Long Wharf (Jones River)	Gloucester
Corliss Landing	Gloucester
Porter River	Danvers
Danvers River	Salem
Lynn Harbor	Lynn
Winthrop Harbor	Winthrop
Back River	Weymouth
Scituate Harbor	Scituate
Green Harbor	Marshfield
Plymouth Harbor	Plymouth
Blush Point	Barnstable
Sesuit Harbor	Dennis
Rock Harbor	Eastham
Pamet River	Truro

The Public Access Board of the Department of Fisheries, Wildlife and Environmental Law Enforcement (DFWELE) has published a guide called Public Access to the Waters of Massachusetts, which lists the locations and facilities available at all 123 state-funded boat ramps across the Commonwealth.

Whale watching, another favorite coastal pastime, has grown tremendously in popularity over the past decade. Whale watching cruise ships now leave from many ports along the Massachusetts Bays coastline, including Newburyport, Gloucester, Boston, Plymouth, and Provincetown. In 1986, approximately one million people participated in whale watching cruises generating over $16 million in revenue for the region's economy (EPA, 1990). Stellwagen Bank and Jeffrey's Ledge, areas of prime summer habitat for several species of whales, are two of the most popular destinations for whale watch cruises.

MEGAPROJECTS

Several large, ongoing or proposed projects in Massachusetts Bays will have a significant impact on the water quality and living resources of the Bays. These projects include: the Massachusetts Water Resources Authority (MWRA) Boston Harbor Project, the South Essex Sewage District (SESD) project, the Central Artery/Third Harbor Tunnel (CA/T) project, the Army Corps of Engineers Boston Harbor Navigation Improvement Project, the Army Corps Saugus River Floodgate project, and the Massachusetts Bay Disposal Site.

These projects are discussed here because their large scale and potentially significant impact on the Massachusetts Bays system serve to illustrate the interconnected nature of the Massachusetts Bays system and to highlight the importance of addressing pollution problems in the Bays from an ecosystem-wide perspective. The Bays are a marine ecosystem comprised of currents, tides, nutrient cycles, energy flows and food webs. These natural processes link the ecological health of one part of the Bays to the health of the ecosystem as whole. Consequently, the effects of any one of these megaprojects may be felt in another part of the Bays system. The Massachusetts Bays Program recognizes that the future health of the Bays and continued human use of its resources will require an ecosystem-based management approach. This approach must include an effort to analyze and better understand the greater-than-local impact of large projects in the region.

MWRA Boston Harbor Project

The MWRA is under court order to construct a new sewage treatment facility on Deer Island to replace its existing outmoded primary plants on Deer Island and Nut Island in Boston Harbor. The new plant, scheduled to go on line with primary treatment in 1995, partial secondary in 1996, and full secondary treatment in 1999, will process over 500 million gallons of residential and industrial sewage per day from 43 communities in eastern Massachusetts. The MWRA project is expected to reach a major water quality improvement milestone in late 1991 when a new sludge treatment facility in Quincy begins operation. The opening of this plant will mark the end of sludge disposal into Boston Harbor waters.

In addition to providing the higher level of sewage treatment, the MWRA proposes to further improve water quality in Boston Harbor by relocating the sewage outfall from the existing sites near Deer and Nut Islands to the deeper waters of Massachusetts Bay. The treated sewage would be conveyed through a 24-foot-diameter tunnel to a location more than nine miles seaward from Deer Island. The new outfall will disperse the treated effluent into Massachusetts Bay through 55 riser pipes spaced over a distance of 1 1/4 miles, beginning in 1995.

The entire project, the largest public works project in the history of New England, is expected to be completed over a 10-year period, at a cost of $6.1 billion.

What is the role of the Massachusetts Bays Program in the Boston Harbor Project? From its inception in 1988 following the lawsuit over the pollution of Boston Harbor through the present, the Massachusetts Bays Program has taken an active role in assessing the impacts of sewage-derived contaminants in Massachusetts and Cape Cod Bays. First, by developing an agenda for the research community which is clarifying the sources, fate, transport, and effects of contaminants in the Bays system, the Massachusetts Bays Program is helping to identify and fill in the gaps in our knowledge of the ecosystem. To maximize results from research dollars and to help focus future research, the Massachusetts Bays Program coordinates its studies with related efforts undertaken by the USGS, MWRA, and MIT Sea Grant. In addition, scientists from the Massachusetts Bays Program have been actively involved in the Outfall Monitoring Task Force, established under the direction of the Executive Office of Environmental Affairs (EOEA). This group is helping to develop a monitoring plan, to be implemented by the MWRA, which will collect baseline information on the Bays system and will enable scientists and managers to identify any potential adverse water quality or ecosystem impacts which may require remedial action.

Central Artery/Third Harbor Tunnel Project

The Central Artery/Third Harbor Tunnel Project (CA/T) is a 7 1/2 mile interstate highway construction project that will replace the existing elevated highway through downtown Boston with an underground roadway. The project also includes a third tunnel under Boston Harbor linking the Massachusetts Turnpike to Logan Airport. The project presents several water quality related issues for Boston Harbor, including: dredging of soft sediments from the harbor floor, management of stormwater from new roadways, and disposal of construction and dredged material. The dredging project, to be undertaken as part of the tunnel construction, requires the removal of 1.2 million cubic yards of sediment from the Inner Harbor between South Boston and the airport. Dredged and excavated material, amounting to 11.9 million cubic yards, will be disposed of on Spectacle Island in Boston Harbor. Some highly contaminated sediments will de temporarily stored on Governor's Island prior to treatment.

In November 1990, a Final Supplemental Environmental Impact Report was issued. The EIR concluded that the effects of dredging on Boston Harbor water quality will be limited. High concentrations of suspended solids are expected to be confined to within 150 meters of the dredge operation. Outside this 150-meter band, levels of solids are expected to decrease to amounts normal for the surrounding waters.

According to the EIR, two components of the project are expected to result in water quality improvements. Storm drainage systems currently serving the CA/T project area are combined with sanitary sewers and contribute to Boston's combined sewer overflow problem. The CA/T project proposes to replace this combined system with separate storm and sanitary sewer drains and thus reduce the number of CSO discharges to the harbor. A second water quality improvement is expected to result from the disposal of construction and dredged material on Spectacle Island. The fill will be used to cap an existing landfill that is leaching contaminants into the Harbor.

Boston Harbor Navigation Improvement Project

In November 1989, Congress authorized the Army Corps of Engineers (the Corps) to deepen three major tributaries to Boston Harbor: the Mystic River, Chelsea River Channel, and the Reserved Channel. While Boston Harbor's principal access is 40 feet deep, the three tributaries are only 35 feet deep. The project proposes to deepen the channels to 40 feet or, in the case of the Chelsea River, to 38 feet (depth limited by the presence of utility crossings beneath the channel). The Corps proposal is limited to existing shipping channels. Shipping companies and terminal operators are responsible for deepening the areas around their own terminal facilities. The project is designed to lower shipping costs in Boston by reducing or eliminating delays for large vessels, improve navigation safety and reduce the risk of spills.

Disposal of the dredged material may pose some water quality risks for Massachusetts Bays. Studies of the sediments in the area to be dredged revealed that material from the Reserved Channel is suitable for ocean dumping and will be disposed of at the Massachusetts Bay Disposal Site (MBDS) in Stellwagen Basin. However, sediments from the Mystic and Chelsea Rivers contain contaminants which may render them unsuitable for ocean disposal. The project proposes to dump these contaminated sediments at the MBDS and cap them with clay derived from clean dredged material underlying the Harbor floor. There is concern that this proposed capping technique may not adequately protect Bay waters from contamination. An Environmental Impact Statement is being developed to address disposal and environmental impact issues associated with this project.

The proposed project is scheduled to begin in October 1993 and run for two years. The total cost of the project is estimated at $33,900,000, 65 percent of which will be supplied by the federal government. The Massachusetts Port Authority, (Massport) the local sponsor of the project, will provide the remaining 35 percent of the total cost.

Massachusetts Bay Disposal Site

The Massachusetts Bay Disposal Site is located approximately 22 miles east of Boston in about 300 feet of water at the northeast tip of Stellwagen Basin. The site comprises a circle that is two nautical miles in diameter. Since 1977, this site has been listed as an interim site for the disposal of dredged material. Over the past decade, nearly 3 million cubic yards of dredged material has been disposed at this site. Disposal records indicate that 67% of the dredged material came from Boston Harbor, 20% from areas on the South Shore, and 13% from North Shore areas (USEPA, 1989).

EPA has issued an Environmental Impact Statement (EIS) for the purpose of designating this site a permanent disposal site for dredged material. The final site boundary, however, may be relocated slightly west of the present boundary in an area known as the Industrial Waste Site. Final site designation does not constitute approval for actual disposal of dredged material; it only serves to identify an ocean disposal alternative for individual project reviews. Future sources of dredged material for disposal at the Massachusetts Bay Disposal Site will continue to come from dredging projects within communities from Gloucester to Plymouth (Hubbard et al., 1988).

For many years, the Massachusetts Bay Disposal Site, as well as other sites within Stellwagen Basin, have received a wide range of wastes from human activity including low-level radioactive wastes, toxic wastes, dredged material in the form of contaminated sediments, explosives, ships, and construction debris (Urban Harbors Institute, 1990). Recently, as a result of EPA's issuance of the EIS for the continued use of the Massachusetts Bay Disposal Site, concern has resurfaced over past disposal practices of low-level radioactive wastes and other toxic wastes in both designated and unauthorized areas. Ongoing research by EPA and others is documenting the distribution of barrels scattered throughout large areas. Over the next year, EPA will conduct research on sediment and benthic organism contamination and health in and around the Industrial Waste Site in order to determine if remedial action is necessary.

South Essex Sewage District

The South Essex Sewage District is a regional sewage treatment facility that serves approximately 165,000 people in the towns of Beverly, Danvers, Marblehead, Peabody, and Salem, as well as small segments of Middleton and Wenham. The plant provides primary treatment to an average daily sewage flow of 27 million gallons per day (mgd). Effluent is discharged into Salem Sound approximately 8,000 feet from the plant and 5,000 feet from the nearest shoreline.

SESD is proposing (under court order) to build a new secondary treatment facility to replace its outmoded primary facility. The new facility would provide secondary treatment for a sewage flow of 28 mgd. Current facilities planning follows several years of debate over the construction of a new plant for the region.

In 1988, SESD was ordered by the Massachusetts Environmental Policy Act (MEPA) agency to conduct facilities-siting studies for the new plant and its associated sludge landfill. As of January 1990, five sites were under consideration for the sewage plant. Siting and facilities planning is continuing. An Environmental Impact Report (EIR) on the proposed SESD expansion is expected to be issued by the end of 1991.

The Saugus River Floodgate Project

Another major project planned by the Army Corps of Engineers is the proposed Saugus River Floodgate Project in the municipalities of Lynn, Malden, Revere and Saugus. This project is designed to reduce the impact of tidal flooding in the Saugus and Pines Rivers Estuary. The area encompasses approximately 4,000 acres of residentially, industrially, and commercially developed land and coastal wetlands. It includes approximately one-third of the City of Revere, the Revere Beach backshore, the Lynn Harbor shorefront, East Saugus, and the Pine Brook area of Malden.

Also included are major utilities and transportation arteries that serve Boston's North Shore. The Massachusetts Bay Transportation Authority's Blue Line, Route 1-A, and other important transportation routes serving 100,000 commuters per day cross the project area.

Chronic flooding caused by storm surges and high tides has resulted in substantial damage to homes and businesses in the area. During the Blizzard of 1978, for example, record high tides and storm surges flooded thousands of homes and businesses, forced the emergency evacuation of over 4,000 people, and damaged over 3,000 buildings (COE, 1989). Because of growth in the area and increased reconstruction costs, the same intensity storm today would affect nearly 5,000 buildings and cause over $100 million in property damages.

According to a 1989 feasibility study and EIS, the Corps proposes to build a total of 3.5 miles of structures — dikes, walls, and floodgate — to reduce flooding throughout the area. The floodgate, to be located at the mouth of the Saugus River, would remain open except when there is a threat of a flood. During storm tide conditions, the gates would be closed for a few hours during high tide to restrict the amount of water entering the estuary. The Corps estimates that such closures would occur only two to three times per year, when tides reach elevations of approximately three feet above mean high tide (COE, 1989).

According to the feasibility study, the project will require the acquisition (in fee or easement) of 1660 acres of estuarine land for flood storage and runoff. Although the project does not propose to alter any vegetated wetlands, two acres of intertidal habitat and one acre of subtidal habitat will be lost. Construction of the flood control structures will require the disposal of approximately 114,000 cubic yards of dredged material. The Corps proposes to dispose of this material at the Massachusetts Bay Disposal Site.

The project will be sponsored by the Corps, the Metropolitan District Commission, the Cities of Lynn, Malden and Revere, and the Town of Saugus. The total cost of the project is estimated to be $100 million, 75% of which will be provided by a 1990 Congressional authorization. The project is currently in the engineering and design phase.

CHAPTER III. THE PRIORITY PROBLEMS FACING MASSACHUSETTS BAYS

Users and Use Impairments: The Unbroken Circle

Who uses Massachusetts and Cape Cod Bays? Along with the fishermen and seafood consumers who take advantage of the abundant sea life inhabiting the Bays, and the swimmers and boaters who enjoy the recreational benefits of the coast, everyone who lives in the watersheds of the Bays uses these resources in one way or another. Unfortunately, some of these uses are harmful. Industries and municipalities regularly discharge pollutants via sewage outfalls directly into the Bays and into rivers and streams entering the Bays. Individuals contribute to nonpoint source pollution through septic systems, improper waste disposal, boat discharges, and automobile emissions. Pollutants also flow to the sea by way of discharges to groundwater, or through stormwater runoff. Ultimately, the pollutants affect us by threatening health, degrading beaches, and damaging the fragile habitats of fish, shellfish, and other wildlife.

Land use within the Massachusetts Bays region ranges from the highly-urbanized cities and towns that comprise the Metropolitan Boston area to the smaller rural-residential communities found along the Upper North Shore, South Shore, and Cape Cod areas. Over the past twenty years, the overall population levels within the drainage basin have remained relatively stable; however, Cape Cod and the South Shore have experienced dramatic population growth. Increased development along the coast and within the watersheds of Massachusetts and Cape Cod Bays has created a variety of environmental concerns, particularly regarding wastewater disposal activities (from municipal wastewater treatment plants, septic systems, boats) and stormwater runoff.

Overview of Contaminant Sources

Contaminants entering Massachusetts and Cape Cod Bays, whether they be pathogens or chemicals, come from a variety of sources: municipal wastewater treatment plants, industrial discharges, stormwater runoff, atmospheric deposition, septic systems, and boat wastes. Point source pollution, emanating from discrete locations such as treatment plants and industrial discharges, is regulated by federal and state environmental agencies. Permits are issued to control and monitor discharges of contaminants. Recently, nonpoint source pollution (from diffuse sources such as stormwater and septic systems) has been recognized as a significant contributing factor to degraded water quality along the coast. Some of the important point and nonpoint pollution sources are discussed below.

MUNICIPAL AND INDUSTRIAL DISCHARGES

The waters of Massachusetts Bay receive waste from 13 sewage treatment plants that discharge effluent and/or sludge into these coastal waters. Twenty-seven of the 42 coastal communities between Cape Ann and Provincetown process their sewage through these treatment plants, five of which use primary treatment and eight use secondary treatment. The remaining communities have no treatment plants and rely on septic systems.

The average flow from these 13 plants totals over 566 million gallons per day (mgd), with the majority of the flow (500 mgd) coming from the Massachusetts Water Resource Authority plants serving the greater Boston area. Currently, there is a court order in place overseeing the installation and operation of a new primary treatment plant and ocean outfall by 1995 and a secondary treatment facility by 1999. By the end of 1991, sludge will no longer be discharged into the coastal waters of Boston Harbor.

In some communities around the Bay, the average flows increase dramatically during heavy rainfall events. Combined sewer overflows (CSOs) are typically found in many of the older cities along Massachusetts Bay such as Boston and several North Shore communities. In these communities, the sewage systems were built to combine sewage wastes from residences with stormwater.

Often during heavy rainstorms, the sewage treatments are unable to handle the volume of flow. Therefore, the excess flow is discharged directly into the coastal waters without any treatment.

Industrial discharges enter Massachusetts Bay directly and indirectly through municipal sewage treatment plants in Boston, Gloucester, Salem, Lynn, Cohasset, and Plymouth. Discharges from the largest industries are permitted by federal and state authorities. Approximately 6,000 industries contribute to the wastewater processed by the MWRA.

STORMWATER RUNOFF

Runoff from streets, parking lots, lawns, golf courses, and farms following rainfall events carries a variety of contaminants into coastal waters. These contaminants include sediments, pathogens, nutrients, toxic metals, and pesticide and other organic compounds. Increased development has led to an increase in impervious surfaces such as roads, parking lots, roof tops, driveways, etc., which is contributing to more runoff. Subdivision regulations at the local level frequently fail to address water quality and resource protection concerns, but are simply geared to removing the runoff from roads and other paved surfaces as quickly as possible.

ATMOSPHERIC DEPOSITION

Atmospheric deposition has been identified as an important source for pollutants (metals, nutrients, and organic compounds) to enter coastal environments. Preliminary estimates for Massachusetts Bays indicate that atmospheric deposition may be a major pollution source for certain metals and nutrients. For example, a recent study has found that lead enters the coastal environment of Massachusetts Bays primarily through atmospheric deposition. Unfortunately, there is limited or no data on which to evaluate a number of important atmospheric pollutants and their significance to the Massachusetts Bays ecosystem. Beginning in 1991, the Massachusetts Bays Program will fund a two-year study to characterize annual loadings of certain atmospheric pollutants to the bays.

DISCHARGES FROM COASTAL RIVERS

The drainage basin for Massachusetts Bays consists of 13 separate river basins and coastal drainage areas. It has been estimated that 80% of the average annual riverflow to the Bays is derived from the Merrimack River Basin. A complete description of the coastal drainage areas can be found in Chapter II.

Recent measurements of trace metal levels indicate that the Merrimack River may be a significant source of metals to Massachusetts Bay from industrial and urban sources. Because of its importance as a fresh water source to Massachusetts Bay, the Merrimack River is suspected to also contribute significant loads of organic chemical pollutants. In 1992, the Massachusetts Bays Program will fund a field sampling and measurement program to quantify organic chemical pollutants from the Merrimack River.

SEPTIC SYSTEMS

Parts of Cape Cod and the North and South Shores remain unsewered, and inadequately-designed or maintained septic systems in these areas may be contributing significant amounts of sewage-derived contaminants to groundwater and streams which flow to coastal embayments. Title 5 regulations of the State Environmental Code establish minimum requirements for the subsurface disposal of sanitary sewage. Promulgated in 1978, the regulations were designed primarily for the control of bacteria. Recent scientific research has shown that viruses may not be adequately controlled under Title 5. In addition, the regulations do not address the impacts of nitrogen, which, at sufficient levels, can stimulate excessive growth of algae in sensitive embayments. Results from the Buzzards Bay Project indicate that in Buttermilk Bay (an embayment located in the northeastern end of Buzzards Bay) approximately 85% of the nitrogen entering the embayment

comes from area septic systems via groundwater. In parts of the Massachusetts Bays region, similar situations may exist.

BOAT WASTES

Sanitary waste from marine heads in boats is being discharged into the nearshore waters of Massachusetts and Cape Cod Bays, particularly in and around marinas. Such discharges may contain high levels of pathogens, as well as chemicals used to deodorize and disinfect the waste, and are degrading water quality and affecting resource areas — most notably shellfish beds. The major products used as chemical additives are alcohol, formaldehyde, zinc salts, ammonium salts, and chlorine. A survey of harbor masters conducted by the Buzzards Bay Project indicated that alcohol and formaldehyde are the most common chemicals used.

There are few boat pumpout facilities in the Massachusetts Bays region, and the use of these, both at private and public marinas, is extremely low (F. Courtney, CZM, personal communication). The reasons revolve around convenience, cost, education, and enforcement. The law prohibits boat discharges within three miles of the coast, but many boaters find it more convenient to dump their wastes into marine waters than to invest time and effort into getting their boats to a pumpout facility. Others think that the cost of a pumpout is excessive, even though it is typically less than $10. Moreover, some boaters do not feel that boat waste seriously degrades water quality, or they believe that their own incremental contribution to the overall waste load is too insignificant to make a difference. A complete list of all pumpout facilities in the Massachusetts Bays can be found in the *Environmental Guide for New England Mariners*.

Priority Problems

In order to effectively and efficiently address the major environmental concerns, the Massachusetts Bays Program defined six priority problem areas in the Management Conference Agreement of November 1990. These priority problems were developed in consultation with local, state, and federal government officials, the scientific and academic community, environmental groups, commercial and recreational users of the Bays, and concerned citizens. The priority problems are:

- Chemical contamination of water and sediments
- Bioaccumulation and the effects of chemical contamination
- Pathogen contamination
- Water quality
- Habitat loss and modification
- Sea level rise

The following sections examine each of these problem areas in terms of the sources of pollutants, their regional impact, and ultimately how our ability to use the resources of Massachusetts and Cape Cod Bays is impaired.

CHEMICAL CONTAMINATION OF WATER AND SEDIMENTS

Chemical contaminants of concern in the marine environment of Massachusetts and Cape Cod Bays include the **toxic metals** — lead, copper, cadmium, chromium and zinc; and two groups of **organic chemicals** — polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs). In general, the presence of these contaminants is the result of waste disposal activities, runoff, and atmospheric deposition. They contribute to a variety of adverse impacts on water and sediment quality, marine organisms, and human health.

Many of the same pollutants that affect water quality in Massachusetts Bays also degrade the sediment quality. Contaminants that enter the Bays are initially suspended in the water column and are transported by water movements until the speed of the currents is slow enough to allow them to settle to the bottom. Contaminants in the sediments are of concern because they tend to accumulate over long periods and represent the cumulative loading of many pollution discharges. These low-level, independent discharges, while they may individually meet federal and state pollution control standards, can, over time, combine to result in high levels of toxic pollutants in sediments. Furthermore, chemical contaminants in sediments may last long after the source of the pollution is shut off and may act as a source of further contamination through various pathways.

Recently, the Massachusetts Bays Program completed the first comprehensive survey of the sources of the major contaminants and their relative contribution to pollution in the Bays' ecosystem (Menzie-Cura, 1991). The survey estimated the quantity of contaminants contributed by point sources (sewage treatment plants, industrial wastewater discharges, combined storm and sewer outfalls, and municipal storm sewers) and non-point sources (stormwater runoff, atmospheric deposition, in-place sediments, and groundwater). The relative contribution of contaminants by the five major areas draining fresh water into the bays also was assessed. These drainage areas are the Merrimack River, Boston Harbor, North Shore, South Shore, and Cape Cod.

In general, chemical contamination appears to be more of a problem for the North Shore and Boston Harbor drainage areas where wastewater and runoff from the industrialized centers and urban harbors such as Boston, Salem, and Quincy contain higher concentrations of chemical contaminants. For example, the Boston Harbor drainage area appears to be the major contributor of copper to the Bays, with both point source discharges and runoff contributing to elevated copper concentrations. A major source of copper entering the waste stream is believed to be corrosion of water pipes. On the other hand, lead enters the coastal environment primarily by atmospheric deposition, with runoff and point source discharges also contributing. Sources include leaded fuel and lead water pipes. The highest New England levels of lead in mussels, measured as part of the NOAA Mussel Watch program, were from samples collected near Cape Ann and Boston.

High concentrations of chemical contaminants are most often found in sediments closest to shore near the pollution sources or in depositional areas where particles suspended in the water can easily settle to the ocean floor. For example, the highest metals concentrations in Boston Harbor are generally found in the Fort Point Channel and the mouth of the Charles River, both of which are areas of the Inner Harbor that receive significant flow from combined sewer overflows. While the problem is most pervasive in Boston Harbor, contaminated sediments have been recorded throughout Massachusetts Bays.

One group of organic chemicals of concern to the Massachusetts Bays Program is the polycyclic aromatic hydrocarbons (PAHs). Constituents of petroleum and coal enter the Bays via stormwater runoff from streets, leaking underground storage tanks, car exhaust, worn tire rubber, boats, and soot from backyard barbecues, in addition to oil spills and illegal disposal of used motor oil. They accumulate in bottom sediments and can be transferred up the food chain to the fish and shellfish consumed by humans. Some Boston Harbor sediments have very high levels of PAHs comparable to those of other urban harbors such as New York, Baltimore, and San Diego. Estimates of PAH loadings suggest that point source discharges such as sewer outfalls are contributing the largest quantity of PAHs to the Bays. Atmospheric deposition may be another major contributor.

In general, the three major sources of chemical contaminants to the Bays appear to be:

- Sewage effluent and sludge from municipalities, especially the MWRA outfalls in Boston Harbor
- The Merrimack River
- Atmospheric deposition

The Massachusetts Bays Program will fund additional studies to further refine the relative contribution of the pollution sources. Studies will include field measurements of PAH levels in the Merrimack River, direct measurements of contaminants contributed via the atmosphere, and measurement of PAH levels contributed through runoff from the land.

Contamination of water and sediments by organic chemicals and toxic metals diminishes the ability to use the resources of Massachusetts and Cape Cod Bays in a variety of ways. Public health is threatened through the increased risk of disease associated with eating contaminated seafood. Fish and shellfish are stressed by toxic chemicals in the water and sediment and may develop cancerous tumors or other diseases. Environmental stress may also lead to declines in population levels. The fragile ecology of coastal habitats is threatened by shifts in the types of plants and animals to a less diverse community of pollution-tolerant organisms.

BIOACCUMULATION AND EFFECTS OF CHEMICAL CONTAMINATION

As described in the section above, metal and organic contaminants enter the marine environment from a variety of sources, including municipal wastewater discharges, runoff, and atmospheric deposition. Marine organisms are exposed to chemical contaminants through direct contact with polluted water and sediments and through feeding. Bioaccumulation is a process whereby a substance enters an aquatic organism and is stored within the tissues of the organism.

The marine resources of Massachusetts and Cape Cod Bays have been impaired by the presence of chemical contaminants in the marine environment. This contamination is largely concentrated in the vicinity of urban centers and localized "hot spots." However, continued long-term discharges of chemical contaminants into the marine environment will spread the contamination into more remote locations.

The economic impacts of contaminants in the marine environment are difficult to quantify. Loss of recreationally and commercially-important species through failure to grow and reproduce is not easily documented. While monitoring programs can alert us to the threats to resources, only reducing the flow of contaminants will preserve the marine ecosystem and its bounty of wholesome seafood.

Use impairments related to the presence of chemical contaminants in the marine environment fall into two major categories:

- Degradation and/or alteration of habitat
- Human health impacts related to the accumulation of contaminants in the marine food chain

Habitat Impacts

An environment contaminated by organic pollutants may decrease the ability of marine organisms to grow and reproduce. For example, abnormal larval forms may result from exposure to toxins. Migratory species, such as striped bass and bluefish, are stressed by chronically high levels of PCBs, related to the high fat content of their flesh. Cancerous lesions and fin rot in flounder, as well as black gill disease in lobsters, have all been related to stress due to chemical contaminants.

Marine organisms may store, detoxify, or excrete excess metals, depending upon the metal and the individual species. Elevated metals may lead to alterations in food chain dynamics, changes in the animal species present in bottom (benthic) communities, shifts to metal-resistant types of animals and plants, and consequently, alteration of essential habitat.

Human Health Impacts

Human health impacts of chemical contaminants in marine organisms are difficult to assess. Often, chemical contamination in humans results in either slight changes in the overall risk of cancer or subtle impairments of neurological development in fetuses or children. Because these effects may not be apparent for many years, it is extremely difficult to link consumption to health impacts.

In general, seafood harvested in nearshore environments is the most highly contaminated and thus poses the greatest public health risk. Health advisories by the Massachusetts Department of Public Health warn against the consumption of lobster tomalley from Boston Harbor lobster by the general population, and consumption of fish harvested from Boston Harbor for certain high-risk segments of the population.

Shellfish harvested from chemically contaminated habitats, and migratory bluefish and striped bass, contribute the largest concentration of chemical contaminants to the human seafood diet. These species represent about 1/3 of all seafood consumed (USFDA, 1982a,b). Advisories have been issued in some New England states warning women of child-bearing age and children to limit consumption of bluefish and striped bass.

PATHOGEN CONTAMINATION

Pathogens are disease-causing bacteria and viruses. Pathogen contamination can close productive shellfish beds and recreational swimming beaches. People who come in contact with pathogens either by eating contaminated shellfish or by swimming in contaminated waters face health risks ranging from skin rash to gastrointestinal illness to more serious illnesses such as hepatitis. Public health officials utilize indicator organisms such as fecal coliform bacteria to determine the possible presence of pathogens in the environment.

Shellfish Bed Closures

Shellfish beds are important commercial, recreational, and ecological resources in the Massachusetts Bays system. Over the past twenty years, there has been a dramatic increase in acreage closed to shellfish harvesting. In general, these closures may be the result of increased pathogen contamination, but also appear to be the result of increased water quality monitoring and reporting of the incidence of illness. Most of this increase has taken place on Cape Cod and on the South Shore. Major closures have occurred in areas considered relatively contaminant-free, such as the North and South Rivers.

In reent years, shellfish areas in Boston Harbor and the North Shore have not experienced such dramatic closure levels. (In Boston Harbor, there have not been any open shellfish areas for many years.) Certain areas are classified as "restricted," and only specially state-licensed diggers are allowed to harvest shellfish for depuration.

Like Boston Harbor, much of the North Shore has been closed for many years. However, there are several North Shore communities (such as Ipswich, Essex, and Gloucester, where shellfishing is an important commercial and recreational activity) that have experienced recent increases in closed shellfish areas. In 1990, an estimated $3.4 million was lost to the local economy of Ipswich as a result of shellfish closures due to pathogen contamination (Castonguay, 1991).

The standards used by state agencies to protect the public from health risks associated with pathogen contaminated shellfish were established by the National Shellfish Sanitation Program (NSSP). (See box, page III-7).

NATIONAL SHELLFISH SANITATION PROGRAM

In order to protect public health from shellfish contaminated by sewage, the National Shellfish Sanitation Program (NSSP) was established in the 1920s. Composed of federal, state, and industry representatives, today this program is carried out through a forum known as the Interstate Shellfish Sanitation Conference. In Massachusetts, the Division of Marine Fisheries and the Massachusetts Division of Food and Drugs are the responsible state agencies in the NSSP.
One goal of the NSSP is the proper classification of shellfish resource areas to safeguard public health from pathogen-contaminated shellfish. A major portion of the classification process involves the growing-area survey, or sanitary survey. A sanitary survey must be conducted in each shellfish harvesting area prior to its approval by the state for any harvesting purpose. The sanitary survey has four major components:

- Evaluation of potential pollution sources affecting the area
- Evaluation of the meteorological factors affecting the entrance and dispersal of contaminants
- Evaluation of hydrographic factors affecting the distribution of pollutants in the area
- Assessment of the water quality

The synthesis and analysis of this information to determine the proper classification of the area is referred to as a sanitary survey report.

The classification process requires periodic evaluation and review. Each year, water quality data are collected and analyzed on at least five separate occasions for each approved growing area. Every three years, the classification of each growing area is reevaluated based on the latest survey report and most recent data. Every 12 years, a complete shoreline survey is conducted to pinpoint obvious pollution sources.

A second goal of the NSSP is to determine appropriate classification standards that will protect public health. Fecal coliform bacteria are currently used to classify shellfish harvesting areas. Because public health agencies are not able to measure the entire host of human pathogens directly, they rely on fecal coliform bacteria as an indicator of public health risk. Although the fecal coliform standard appears to be a very conservative measure, legitimate questions have been raised about the accuracy of the method.

The causes of shellfish area closures are varied. Closures have been tied to contamination from both point (municipal sewage treatment plants) and nonpoint pollution sources (septic systems and stormwater runoff). Although municipal sewage treatment plants are known to be major sources of contaminants, in general, the importance of nonpoint sources of pollution has only recently been recognized. For example, on Cape Cod, in 1980, 700 acres of productive shellfish beds were closed to contamination. In 1986, 3,500 acres were closed (Clendenning and Dean, 1990). During this period, more than 36,000 permits for new construction were issued in Barnstable County (Mass. Audubon Society, 1987, quoted in Clendenning and Dean, 1990).

Beach Closures

The presence of pathogens in coastal waters also affects recreational opportunities in Massachusetts Bays. In 1989 and 1990, most of the major beaches in Boston Harbor were posted as polluted at least once during the summer months. High bacterial levels have also forced the closure of beaches on the South Shore. In and around the older cities of the Bays, the highest frequency of beach closures occurs after rainstorms, when large amounts of untreated or partially-treated sewage and runoff are discharged to coastal waters.

WATER QUALITY

In addition to the chemical contaminants and pathogens that affect the quality of the marine environment, other parameters discussed below affect the quality of water and sediments within Massachusetts Bays. Aquatic organisms require good water and sediment quality for survival, growth, and reproduction. Under inadequate conditions, the individual organism may reproduce poorly, die, or move from the area. If the impacts upon individual organisms are too stressful, entire populations or communities may be affected.

Nutrients

High levels of nutrients, primarily nitrogen, can cause water quality problems in the marine environment. Excessive amounts of nitrogen may trigger a condition called eutrophication, characterized by excessive algal growth with resultant depletion of dissolved oxygen and possible fish kills. Increased abundance of algae can limit the transmission of light reaching eelgrass leaves, resulting in loss of eelgrass beds that provide habitat for shellfish and other animals. Algal blooms also impair recreational and aesthetic enjoyment of coastal waters.

Nitrogen is conveyed to coastal waters by various pathways, including sewage treatment plant outfalls, atmospheric deposition, groundwater flow, and residential and agricultural runoff. A recent study of pollutant loadings to the Massachusetts Bays (Menzie-Cura, 1991) indicated that point source discharges account for 43 to 66 percent of the total nitrogen entering the bay waters. Other important sources include river discharges (37 percent), atmospheric deposition (16 percent), and surface runoff (11 percent). The report also found that groundwater is an important source of nitrogen for the nearshore waters of Cape Cod.

Dissolved Oxygen

Minimum levels of oxygen in the water (dissolved oxygen) are vital for the survival of aquatic organisms. Wastewater and naturally-occurring organic matter contain oxygen-demanding substances that consume dissolved oxygen. If the amount of dissolved oxygen in the water is too low, then organisms may die.

Concentrations of dissolved oxygen in the waters of Boston Harbor are usually within a range adequate to support marine organisms. Sampling conducted by the Division of Water Pollution Control over several years indicated that the lowest dissolved oxygen is found in the Inner Harbor, where frequent violations of water quality standards and stressed environmental conditions occur. In 1984, violations of the dissolved oxygen standards in the Inner Harbor occurred about 40 percent of the time. Low dissolved oxygen levels also have been reported in the immediate vicinity of the Deer Island sewage and sludge outfalls and in the Outer Harbor near Winthrop. Other isolated areas exhibit violations after storm events due to inputs of oxygen-depleting wastes from combined sewer overflows.

Suspended Solids

Suspended solids consist of organic or inorganic particles suspended in and carried by water. The term includes sand, mud, and clay particles, as well as solids found in wastewater. Suspended solids introduced into coastal waters can increase turbidity, thereby deceasing the amount of light that penetrates through the water column. High turbidity is frequently harmful to marine plants and benthic animals, particularly their planktonic larval stages.

Solid materials suspended in coastal waters can originate from both natural and man-made sources. Effluent from the MWRA sewage treatment facility is the largest source of suspended solids in Boston Harbor. Other important sources are rivers and surface runoff. Concentrations of suspended solids in Boston Harbor are highly variable due to the effects of currents and winds

on the settling and resuspension of solid particles. In the first 2 _ years of the New England Aquarium's 10-year Boston Harbor Monitoring Program, the highest levels of suspended solids were found at the outlet of the Neponset river; lowest levels were recorded in Quincy Bay (Robinson et al, 1990).

HABITAT LOSS/MODIFICATION AND RESOURCE DEPLETION

Massachusetts is estimated to have lost approximately 30% of the total wetland acreage and 20% of coastal wetland acreage existing at the time of the colonists; another 1,000 acres, or nearly 0.2% of the state's remaining coastal and inland wetlands are lost annually (Massachusetts Audubon Society, 1991). Although Massachusetts has enacted wetlands protection regulations, losses continue to occur as a result of direct development, both public and private, and secondary alterations. It is the cumulative effect of these activities that reduces valuable habitat. The combined effects of habitat encroachment and degraded water and sediment quality stresses all marine organisms, including important commercial species, marine mammals, endangered species, and the food chain upon which they depend.

While habitat loss in the Massachusetts Bays diminishes both the quantity and quality of coastal and marine resources, direct depletion of resources through overharvest is also of concern in the region. The Magnuson Fishery Conservation and Management Act of 1976 was intended to salvage decimated stocks by relieving foreign fishing pressures. But stocks rebounded only temporarily before an increase in the number of U. S. fishing boats and the use of sophisticated fishing technologies strained the fishery again. Recently, commercial landings of many species in Massachusetts Bays and offshore waters have plummeted to record lows. Massachusetts mimics the New England-wide trend, with haddock landings down 84% since 1978, yellowtail flounder down 55%, winter flounder 31%, and Atlantic Cod 13%. The ecological impact of this depletion is every bit as profound as the economic impact: species composition and relative abundance have been altered. So-called "trash species", such as sharks, skates, and dogfish, have replaced the valuable groundfish, which now comprise less than 50% of the bottom biomass in Massachusetts Bays. Pelagic species like the Atlantic bluefin tuna, sharks, and billfish are also showing signs of population decline due to pressures including overfishing.

The New England Fishery Council's Northeast Multispecies Management Plan for groundfish currently contains indirect controls on the fishery, mostly minimum mesh sizes for fishing nets, minimum fish sizes, and closed areas to protect spawning fish. Direct controls on fishing — such as quotas on landings, trip limits, or a moratorium on entry — are being considered and may be necessary to allow stocks to recover. New management measures are also being considered by NMFS for the pelagic species.

SEA LEVEL RISE

Over the past 3 million years, sea level has fluctuated in response to changes in global temperature. Currently in a warming period, sea level has been rising since the retreat of the last continental glaciers over 15,000 years ago. Tidal data collected over the past century indicate that sea level is rising at an average rate of one foot per century, worldwide. Recent studies, however, indicate that the present rate of sea level rise may accelerate dramatically within the next 10-100 years due to global warming caused by the "greenhouse effect." Predictions vary widely, but the accelerated sea level rise caused by global warming could raise water levels 2 to 12 feet by the year 2100.

As a result of geologic processes, some land areas are rising or matching sea level rise. Massachusetts, on the other hand, is sinking at this time. This land subsidence, combined with sea level rise and our long-term attraction to the coast, creates a need for local coastal planning.

Recent data indicate that the net loss of coastal land areas (uplands) due to sea level rise is 65 acres per year for the state, based upon the historic sea level rise of one foot per century. When increased sea level rise rates are employed, the loss of land is significantly greater. Also, the variation

between communities is great, according to the geology of the region where the communities lie. For example, Barnstable loses 3.72 acres per year, while Winthrop loses only 0.06 acre. Using the maximum projected rate of sea level rise, Winthrop will lose 9.8 acres while Barnstable will lose over 583 acres by the year 2025. (Giese et al, 1987).

Data also indicate that sea level rise could be a major cause of wetlands loss and subsequent habitat alteration in the coastal zone (Titus et al., 1988). Coastal wetlands and salt marshes are among the most productive ecosystems in the world and provide habitat for many coastal and marine organisms. These habitats are generally within a few feet of sea level and could be lost if sea level rises significantly. Although new marshes and wetlands could form where inland areas are flooded, this cannot happen where the land adjacent to today's wetlands is developed and where upland topographic characteristics inhibit natural wetland migration. In many areas, the land gradient above the marsh is appreciably steeper than the marsh, so a rise in sea level will cause a net loss in marsh acreage. (Titus et al. 1988) Thus, coastline topography and development in the coastal zone could combine to severely limit the ability of salt marshes and other important coastal habitats to survive projected sea level rise in the next century.

Rising sea level will affect the ability to use and enjoy the resources of the Bays in a number of ways. Six major issues include:

- Loss of uplands or land area
- Increased flooding impacts
- Loss of wetlands
- Accelerated shoreline changes
- Salt water intrusion into drinking water supply wells
- Elevated ground water levels

Long-range land use planning in communities along Massachusetts and Cape Cod Bays must take these issues into consideration.

Closing the Circle

As discussed in the sections above, the priority problems defined by the Massachusetts Bays Program relate to the use and abuse of marine resources. Human wastes and chemical pollutants and wastes flow into the fragile coastal ecosystem. In developing coastal areas for human uses, we may destroy critical habitat, create public health risks, destroy the aesthetic qualities we cherish, and limit access to the fortunate few.

Human use of marine resources has led to serious use impairments of coastal areas. To close the circle, we must begin to provide solutions. The chapter that follows provides a series of proposed actions to address use impairments related to public health, habitat loss, aesthetic quality, and waterfront access.

CHAPTER IV. ACTION PLAN

Utilization of Massachusetts Bays' resources carries with it an obligation of preservation and stewardship of those resources. To respond to this obligation, the Massachusetts Bays Program was launched to address mounting threats to the natural resources of Massachusetts and Cape Cod Bays. At the heart of the program is the CCMP Action Plan. This action plan prescribes immediate and long-term actions that can and should be taken by the Massachusetts Bays Program, various governmental agencies, and the general public to restore and preserve the Bays' ecological integrity. The management recommendations contained in this action plan are organized into four topics:

- Public Health Risks
- Living Resources and Habitat Protection
- Aesthetic Quality
- Waterfront Access: Public Access and the Working Waterfront

PUBLIC HEALTH RISKS

Concerns about public health related to marine waters center on two sources of potential risk: consumption of seafood and swimming. These activities or uses associated with marine waters can be threatened or negatively impaired by contamination resulting from polluted waters. This contamination can lead to an increase in the risk of adverse health effects to humans.

Regular consumption of marine fishery products provides substantial health benefits and, as an important low-fat protein source, should be an integral part of a well-balanced diet. Fish is an excellent source of omega-3-fatty acids which reportedly contribute to decreasing risk of heart disease. In addition, fish is low in saturated fat and therefore beneficial in reducing risk of heart disease, diabetes, and some cancers. However, these important benefits can be negated if the product is contaminated or if the public avoids it due to the perception of poor quality.

Media publicity of pollution in Massachusetts coastal waters tends to raise public fear and confusion over eating seafood and is damaging to the state's economy. For example, following the release of the EPA's Quincy Bay Study in 1988 and the accompanying state health advisories, lobster sales reportedly fell 30%, and all seafood sales suffered (Kipp, 1990b). The local seafood industry is a major feature of the state's tourist appeal, and recreational and charter boat fishing are significant contributors to local economies within the Massachusetts Bays area.

The Massachusetts Bays Program recognizes the health benefits of seafood consumption, the economic importance of the state's commercial and recreational fishing industries, and the value of improving recreational opportunities in Massachusetts Bays. As a result, an important objective of the Program is to reduce public health risks from environmental contaminants. This action plan presents an overview of the major types of risks to public health from the consumption of fish and shellfish, as well as risks from direct contact or swimming. It discusses existing government programs to protect public health and control the sources of the contaminants of concern. Finally, this action plan recommends steps the Program must take over the next two years to begin meeting its programmatic goals for protecting public health, improving water and sediment quality, and encouraging pollution prevention.

An Overview of Public Health Risks

PATHOGENS

Pathogens are disease-causing organisms and viruses. In this document, the term pathogen refers to disease-causing bacteria and viruses. While some pathogens may occur naturally in the marine environment, most are introduced to marine waters via wastewater treatment plant discharges, combined sewer overflows (CSOs), septic systems, illegal sewer hook-ups and discharges, marine sanitation devices, and stormwater runoff. Contamination from pathogens is primarily associated with consumption of bivalve shellfish, not finfish or crustaceans, such as crabs or lobsters. Edible shellfish such as the soft-shell clam or mussel feed by filtering seawater through their bodies, thereby allowing certain pathogens to enter their digestive tracts and possibly reside there for a period of time. While scallops feed in the same manner, pathogens are generally not a problem since only the adductor muscle, not the visceral portions of the animal, are typically consumed.

Shellfish

While current nationwide shellfish sanitation practices have significantly reduced shellfish-associated illnesses of bacterial origin, the same is not true regarding human pathogenic viruses. Recent data indicate that shellfish-associated gastroenteritis of viral origin is on the increase, with over 75% of all reported cases occurring since 1980. This alarming trend, along with the fact that over the past 20 years (1970-1990) there has been a 300% increase in the acreage of Massachusetts shellfish harvesting areas closed because of bacterial contamination, threatens the economic stability of the shellfish industry and the public's confidence in the wholesomeness of the seafood.

Two facts should be kept in mind when considering these previously-mentioned trends. First, however alarming the trends may appear, increased reporting (in the case of viral diseases) and surveillance (in the case of shellfish harvesting areas) in recent years obscures the actual magnitude of the problem. Secondly, the threat of viral and bacterial transmission from shellfish occurs primarily when consuming raw or inadequately-cooked products.

Bathing Beaches

Swimming in sewage-contaminated waters poses a potential health risk from diseases transmitted via the fecal-oral route. While most of the reported outbreaks of infectious diseases associated with bathing beaches are non-enteric (for example, skin rash), there is some risk of gastrointestinal disease from swimming in sewage-contaminated water. Based on the present standards, the Massachusetts Water Resources Authority reports that most of the major beaches in Boston Harbor were closed at least once during the summer months in 1989 and 1990. The major risk to the public occurs during and after major rainfall events when untreated sewage and stormwater enter the Bay.

The Indicator Organism

In order to properly assess the threat to public health in marine waters, public health officials utilize a system of "indicator organisms." The indicator organism is one that, by its presence at certain levels, "indicates" the potential for the presence of human pathogens. The indicator organisms currently used are a group of bacteria called fecal coliform. The use of such indicators, as opposed to the direct measurement of the pathogens themselves, is necessary, in part, because of the lack of assay methods for the multitude of potential pathogens.

The use of indicator organisms presents some difficulty in assessing the actual risk to public health. Under certain circumstances, fecal coliform densities bear little, if any, quantifiable relationship with the viral pathogens. In some instances, fecal coliform serve as an overly conservative indicator of the public health threat (such as areas impacted by non-sewage contaminated stormwater), while in other areas, the fecal coliform may not persist as long as viral pathogens and, therefore, may underestimate a public health threat.

To address these problems, there has been a continuing search for a better indicator of human sanitary-waste contamination. Recently, the use of *Enterococcus* (another group of bacteria found in the feces of warm-blooded animals) has been recommended by EPA for use in swimming areas. However, current research has questioned its utility in certain areas, such as near marshes.

Until a better indicator organism is discovered for detecting human sanitary waste, the fecal coliform standard will be retained for use in swimming areas (where areas close if levels exceed 200 fecal coliform colonies per 100 milliliters (ml) of sample) and shellfish harvesting areas (where areas close if the geometric mean population exceeds 14 colonies per 100 ml of sample).

While the use of this standard has generally protected the public health, the potential for underestimating the public health threat due to viruses is inherent and will occasionally result in the transmission of infectious disease. Conversely, since fecal coliform do not differentiate human and animal sources (which may have different public health risks associated with them), public health officials may err to the conservative side when high fecal coliform densities are observed. While this closure policy may appear to be relatively unimportant, in the case of shellfish harvesting areas, an overly conservative closure of areas affects the livelihood of those involved in the shellfish industry.

NATURALLY OCCURRING TOXINS

Paralytic Shellfish Poisoning

One naturally-occurring seafood toxin of concern to the Massachusetts Bays area is paralytic shellfish poisoning (PSP). PSP is caused by a tiny microorganism known as the dinoflagellate, *Alexandrium tamarense*. When the PSP-causing organism is present in large numbers, it is often referred to as "red tide". PSP is potentially life-threatening and there is no known antidote. Symptoms of this illness include tingling of the mouth and lips, numbness in the extremities, progressive muscular paralysis and, in severe cases, death due to respiratory failure. Shellfish that are harvested as part of a recreational or subsistence fishery appear to pose the greatest health risk because individuals may not be aware of a problem or do not heed the warnings.

Data from the Centers for Disease Control (CDC) indicate that between 1978 and 1985, there were 15 reported cases of PSP in Massachusetts. While the Northeast Technical Services Unit (NETSU) of the US Food and Drug Administration (FDA) reports 41 cases in the same period, milder cases may actually go unreported to health authorities. The incidence of PSP is relatively low considering that the dinoflagellate has been present in Massachusetts coastal waters each spring and summer since monitoring began in 1972.

The system of monitoring coastal waters as well as the marketplace for indications of PSP by the Massachusetts Division of Marine Fisheries (DMF) and the Massachusetts Department of Public Health (DPH), respectively, appears to provide adequate public health protection. However, PSP-contaminated shellfish are being detected in areas beyond the coastal waters.

As part of the Massachusetts Marine Biotoxin Monitoring Project, the DPH has been sampling the offshore shellfisheries of Nantucket Shoals and Georges Bank since May 1990. These data indicated extremely high levels of PSP toxins in multiple species of shellfish from Georges Bank. Also in 1990, there were eight reported cases of PSP linked to mussels harvested from the area. The Secretary of Commerce has closed the Georges Bank surf clam and ocean quahog fisheries indefinitely as a result of persistent residual toxicity in these species.

PSP data gathered to date in 1991 indicate a very mild bloom of the dinoflagellate in coastal waters along the North Shore. The DPH did not measure a corresponding increase in offshore toxicity.

Other

Other natural toxins of **potential** concern to the Massachusetts Bays area include amnesic shellfish poisoning (ASP) and diarrhetic shellfish poisoning (DSP). ASP was first reported in

1987 after an outbreak in Atlantic Canada involving 103 people who reported symptoms of vomiting, abdominal cramps, diarrhea, disorientation, and memory loss (Institute of Medicine, 1991). The chronic component of this illness includes permanent loss of short-term memory and damage to the central nervous system. ASP is caused by domoic acid (the causative agents are *Nitzschia pungens* and *Nitzschia pseudodelicatissma*).

In Massachusetts, the DPH is monitoring for domoic acid contamination as part of its Marine Biotoxins Monitoring Program in offshore waters and three coastal sites (Gloucester, Marshfield, and Nantucket). Domoic acid toxicity was first detected in November 1990 in whole bay scallops and mussels harvested from Nantucket. The levels peaked in January 1991 at 10 micrograms/gram, which is one-half the Canadian guideline (J. Nassif, DPH, personal communication). Data have indicated short-lived episodic offshore toxicity in mussels and sea scallops at trace levels.

DSP is an acute gastrointestinal illness caused by the ingestion of shellfish contaminated with okadaic acid and related polyether toxins. DSP can be confused with other pathogenic foodborne illnesses. While there have not been any reported outbreaks of DSP in the United States (the causative agent, *Dinophysis* spp., does occur in US coastal waters), it is common in Japan and Europe and there was one reported case in Canada in 1990. As a result, **imported shellfish** appear to pose the most likely risk of DSP at this time. The DPH has ceased DSP testing primarily because of the lack of reliable analytical methods for detection.

CHEMICAL CONTAMINANTS

Chemical contaminants of particular concern to the Massachusetts Bays area that have been observed at elevated levels include metals — cadmium, lead, chromium, copper, and zinc — and the organic chemicals — polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) (Menzie-Cura, 1991). Marine organisms exposed to these compounds can accumulate them in their tissues, and when consumed by humans may pose a health risk. Accumulation of chemical contaminants by fish, shellfish, and crustaceans depends on a number of factors, including geographic location, species, feeding patterns, the nature of the contaminant, and its persistence in the environment (Institute of Medicine, 1991).

In general, human health risks posed by chemical contaminants in the marine environment are difficult to assess because of the lack of understanding between the level of contaminant exposure and human illness. As a result, the seriousness of this issue remains uncertain at both the national and state levels.

Typically, health effects from chemical contaminants are not immediately manifested as an acute illness. Often, chemical contamination may result in "modest changes in the overall risk of cancer" or "subtle impairments of neurological development in fetuses or children" (Institute of Medicine, 1991). Because these effects may not be apparent for many years, it is extremely difficult to link consumption to health impacts.

In the Massachusetts Bays area, there has been only one site-specific study that addresses the potential threat to public health from chemical contaminants in the marine environment. Results of a risk assessment performed as part of the 1988 EPA study of Quincy Bay pollution concluded that "the risks of regular consumption of lobster tomalley (the hepatopancreas) from Quincy Bay lobsters were high relative to those from other types of eating and drinking activities" and "long-term consumption of very large amounts of Quincy Bay flounder and/or lobster muscle potentially posed risks higher than those of other generally accepted risks of eating and drinking activities" (US EPA, 1988).

As a result of the Quincy Bay study, Massachusetts issued two health advisories. One advises against the consumption of tomalley from all lobsters regardless of the area from where they were harvested. The second advisory recommends limiting the consumption of Boston Harbor fish

products (lobster, flounder, soft-shell clams and other bivalves) by certain high-risk segments of the population (children, nursing or pregnant women, and individuals with suppressed immunity).

PATHOGENS

The standards used to protect the public from shellfish-associated diseases were products of a 1925 Conference on Shellfish Safety. Since then, with the cooperation of all shellfish-producing states, the National Shellfish Sanitation Program (NSSP) has refined the practices of proper shellfish sanitation and management of shellfish growing areas. Since the early 1980's, this work has been accomplished through a forum known as the Interstate Shellfish Sanitation Conference (ISSC).

The NSSP/ISSC is comprised of federal and state health officials and industry representatives which meet annually to discuss proper procedures for ensuring the wholesomeness of shellfish. At the federal level, the Food and Drug Administration (FDA) is the primary participating agency in the NSSP. The National Marine Fisheries Service (NMFS) and the Environmental Protection Agency (EPA) also participate in Conference activities. In Massachusetts, the Division of Marine Fisheries (DMF) is the state agency with primary responsibility for properly classifying shellfish growing areas, while the Division of Foods and Drugs (DFD) is involved with a shellfish plant inspection and market testing program to ensure that shellfish at market meet acceptable bacteriological standards. In addition, a shellfish tagging program enforced by DMF, DFD, and FDA, as well as local health inspectors, ensures that marketed shellfish are harvested from approved areas. In the event of an outbreak of shellfish-related disease, this tagging program also serves to locate the source of the contaminated product.

The goals of the NSSP are to properly classify shellfish resource areas and to determine appropriate classification standards. Under present NSSP guidelines, the classification process in shellfish harvesting areas requires periodic evaluation and review. Briefly summarized, the review process is comprised of the following elements:

- Water quality data are collected and analyzed on at least five separate occasions annually.
- Every three years, the classification of each growing area is reevaluated based on the latest survey report and recent data.
- Every 12 years, a complete sanitary survey (which includes a shoreline survey for existing and potential pollution sources) is conducted.

In 1989, the DMF initiated sanitary surveys along the Massachusetts coast. Assistance was provided by local officials. These surveys were conducted as part of the shellfish classification process of the NSSP.

Regarding swimming beaches, local boards of health generally are responsible for enforcing the state's Sanitary Code, Chapter 7, *Minimum Standards for Bathing Beaches*. This code calls for monitoring the bacteriological and physical quality of water at bathing beaches on a regular basis. In the Metropolitan Boston area, many public beaches fall under the jurisdiction of the Metropolitan District Commission.

NATURALLY OCCURRING TOXINS

Also as part of the NSSP, the DMF regularly collects and analyzes samples of shellfish for PSP where the blooms are likely to occur. The DMF monitors 18 locations along the coast on a weekly basis from mid-March to early December (Hickey, 1989). If the toxin reaches 80 micrograms per 100 grams of edible portions of raw shellfish meat, the area is closed to harvest.

The DPH monitors for ASP as part of its Marine Biotoxins Monitoring Program conducted with funding from FDA. This program is a two-year effort which began in May 1990. Offshore sampling is performed every two weeks while coastal sites are sampled weekly. Neither the federal nor state governments have established a regulatory limit for domoic acid. The Canadian guideline for closing shellfish areas is 20 micrograms per gram.

CHEMICAL CONTAMINANTS

Regulation and Control

Protecting human health by regulating and controlling chemically-contaminated fishery products is also joint federal-state responsibility. FDA has the lead responsibility for seafood in interstate commerce. For some chemicals in foods, specifically pesticides, EPA assists FDA in performing technical evaluations.

The federal government is not directly responsible for protecting individuals who consume fish not part of interstate commerce or fish harvested from locally-contaminated areas. Subsistence or recreational fishermen generally fall within the scope of the Division of Marine Fisheries or the state's Department of Public Health.

As part of the Federal Food, Drug and Cosmetic Act, the FDA is responsible for setting action levels and tolerances for concentrations of chemicals (other than pesticides) in all food products, including fish and shellfish. This Act authorizes EPA to set such levels and tolerances for pesticides. FDA possesses the enforcement authority for guidelines developed by both EPA and FDA.

To date, the FDA has established "action levels" for a number of pesticides and one metal (methyl mercury). A tolerance has been established for one group of organic chemicals, PCBs. Action levels and tolerances are developed to provide national protection and are based on average national consumption rates. They are not intended to protect local segments of the population whose consumption of fish may exceed the national average, such as recreational or subsistence fishermen.

In Massachusetts, the DPH is responsible for protecting public health. As stated earlier, there are two public health advisories in effect regarding the consumption of seafood that were issued following the 1988 Quincy Bay study. In addition, the DMF assists the DPH in its actions to protect public health by providing information as necessary. In the case of PCB contamination in New Bedford Harbor, the DPH has closed the entire Inner Harbor and portions of the Outer Harbor and surrounding waters to fishing and lobstering.

Monitoring

Several data gathering/monitoring programs are being carried out within the Massachusetts Bays areas by federal and state agencies, universities, and environmental organizations. In general, these data have begun to document the nature and extent of chemical contamination. However, there is no comprehensive long-term monitoring program to support the development of management strategies to protect human health. The DMF monitors trace metal concentrations and PCBs in six marine species from a wide geographic area along the Massachusetts coast and from two polluted embayments — Salem Harbor and Boston Harbor. This program is providing needed baseline information on the level of metals found in edible portions of fish and shellfish.

The Department of Environmental Protection (DEP) monitors and assesses the quality of the Commonwealth's surface and groundwater, including marine waters. Data collected are used to determine if the designated use of a water body is meeting the classification standard. The parameters for monitoring include: dissolved oxygen, temperature, pH, fecal coliform bacteria, nutrients, metals, and priority organics. Data on toxicants are collected from sediment, water column, and fish tissue samples.

PATHOGENS

Eating **raw** shellfish poses the greatest public health threat. Thorough cooking of shellfish would eliminate microbial pathogens. The current standard used to classify shellfish areas provides adequate public health protection from most bacterial pathogens associated with sewage, but research is needed to develop valid indicators of human enteric viruses. While steps can be taken to reduce or minimize risks to public health from eating shellfish, ultimately there must be proper treatment and disposal of sewage to avoid pathogen contamination in coastal waters, particularly those used for shellfish harvesting and recreation.

NATURALLY OCCURRING TOXINS

Despite the annual occurence of outbreaks of the dinoflagellate blooms responsible for PSP, current monitoring efforts in coastal waters by the DMF appear to provide adequate public health protection. However, other than the two-year effort underway to monitor offshore waters, there is no effective longer-term monitoring strategy for the shellfisheries of Georges Bank and Nantucket Shoals. Similarly, selected monitoring for domoic acid is underway as part of the same two-year program. This program is scheduled to end in May 1992.

CHEMICAL CONTAMINANTS

Massachusetts coastal waters, sediments, and fishery resources are contaminated by a variety of chemicals for which there are no federal limits. Limited data are available that document the levels of these chemical contaminants in the edible portions of fishery resources. Information is also insufficient regarding the relationship between exposure and illness. There is adequate data for PCBs and mercury, two contaminants for which federal standards have been determined.

There is a need to better educate the public about seafood safety. In many cases, public perceptions may not be linked to actual conditions. For example, results of a risk assessment performed by FDA in 1990 report the incidence of disease from seafood other than raw shellfish is significantly less than from eating chicken (Klauber, 1991).

Conclusions

GOALS

- Protect public health by minimizing risks from environmental contaminants.
- Protect and improve water and sediment quality.
- Encourage pollution prevention and other environmentally sound methods of treatment, cleanup, and restoration.

OBJECTIVES

- Improve the quality of shellfish growing waters.
- Increase acreage of harvestable shellfish beds by 10% per year.
- Make all beaches swimmable year-round and all waters swimmable all summer.
- Minimize public health risks from the consumption of fish and shellfish from Massachusetts Bays.
- Reduce pathogens and toxicants entering Massachusetts Bays.

STRATEGIES

- Increase public awareness/education to improve understanding of potential risks and decrease exposure; as a follow-up, evaluate the effectiveness of actions taken.
- Provide incentives and technical assistance to local municipalities to identify and priority rank shellfish areas and swimming beaches in order to correct known pollution sources.

Goals, Objectives and Strategies

- Promote pollution prevention as a means to reduce contaminants entering the coastal environment. For example, support the use of public transportation, recycling, household hazardous waste collection programs, etc.

Recommended Actions

Massachusetts Bays Program (MBP) will:

- Produce a risk assessment study in 1992 to determine the relative importance of the various contaminants and pathogens entering Massachusetts Bays in terms of public health risks.
- Produce a Characterization Report in 1992 which will incorporate information on sources, transport, fate, and effects of contaminants from historical sources as well as incorporate the results of MBP sponsored and coordinated research.

PATHOGENS

Massachusetts Bays Program (MBP) will:

- Review and comment to DEP on proposed revisions to Title 5 for applicability to coastal areas (e.g., viral transport and nutrient loading).
- Educate consumers about the health benefits of seafood and how to reduce risks from microbial contamination.
- Develop, in cooperation with the EOEA Marine Sanitation Device Task Force, protocols for enforcing MSD standards by the Coast Guard; MBP and CZM will explore the possibility of state and local enforcement.
- Remain informed about, and support the development of, better viral indicators.
- Fund a series of demonstration projects relating to the reduction of pathogens levels affecting shellfish beds.

EOEA should:

- Fund the DMF Shellfish Sanitation Program as originally intended (currently this program is staffed at a 50% level).
- Establish more publicly-funded, state-certified water testing laboratories in order to respond more quickly to rainfall events and increase sampling efforts.

Municipalities should:

- Collaborate with DMF to identify and fix contamination sources. This collaboration should be formalized and institutionalized, with monthly updates of activities given at board of health and/or board of selectmen meetings.
- For coastal areas served by septic systems, review and update regulations governing these systems and maintain a strict adherence to setback and distance-to-groundwater requirements in sensitive coastal settings. Municipalities should also review their policies on granting variances to ensure that they are consistent with environmental and public health objectives.
- Utilize 1989 sanitary survey information (as well as other more recent information), priority rank shellfish areas in need of remediation, and take the necessary action to correct known sources of pollution (i.e., failing septic systems).
- Collect and analyze available data on swimming beach closures to identify pollution sources and then undertake action to remediate the source.

- Obtain appropriate training for all volunteer review boards such as boards of health, conservation commissions, etc., as well as water quality task force groups.
- Adopt strict regulations prohibiting additional stormwater discharges and/or volume additions to present discharges.
- Investigate dry-weather flow conditions on all stormwater discharge pipes to eliminate the possibility of sewage connections.
- Explore obtaining conditionally-approved classification for appropriate resource areas impacted by stormwater runoff.
- Consider the formation of task forces to address water quality issues. Representation should include selectmen, resource management personnel, and citizen groups.
- Institute regulations for random testing of Marine Sanitation Devices to ensure that sanitary wastes are properly disinfected.
- Assure effective and reliable sewage treatment and disinfection at wastewater treatment plants, and reduce or eliminate the discharge of CSOs.

BIOTOXINS

FDA and **NMFS** should:

- Develop and implement a long-term monitoring and management strategy for offshore waters for PSP.

FDA, DMF, and **DPH** should:

- Review the data collected between 1990 and 1992 as part of the Massachusetts Marine Biotoxin Monitoring Project to determine if a regulatory limit for domoic acid should be established and if continued monitoring for domoic acid is necessary.

CHEMICAL CONTAMINANTS

Massachusetts Bays Program (MBP) will:

- Synthesize existing information and identify toxic chemical "hot spots" throughout the Massachusetts Bays area.
- Review and evaluate NPDES discharges to the Massachusetts Bays study area; DEP should verify discharges through a selected sampling program.
- Educate consumers about the health benefits of seafood and how to reduce risks from chemical contamination.
- Fund research on the sources, transport, and fate of organic contaminants (including PCB and PAH) entering Massachusetts Bays via wastewater, industrial discharges, runoff, and atmospheric deposition.

EOEA should:

- Develop sediment criteria for selected contaminants to protect both the ecosystem and human health.

EOEA and **Department of Public Health** should:

- Increase monitoring efforts to document the presence of chemical contaminants in the edible portion of fishery products in order to better assess public health risks and develop control strategies.

Municipalities should:

- Explore innovative ways to fund and establish programs to collect and properly dispose of household hazardous wastes on a regular basis.

Industries that discharge directly into coastal receiving waters or sewage treatment facilities should:

- Continue to reduce toxic wastes with assistance from the Office of Technical Assistance within EOEA.

LIVING RESOURCES AND HABITAT PROTECTION

The coastal and marine waters of Boston Harbor, Massachusetts and Cape Cod Bays, and the adjoining coastal zone, contain abundant and diverse natural resources. These resources offer untold ecological, economic, and recreational benefits to the Commonwealth's citizens. Unfortunately, they are being degraded or threatened from a number of fronts: direct encroachment, unmanaged growth in upland areas, and pollution from a multitude of sources.

One goal of the Massachusetts Bays Program is to support the protection, restoration, and enhancement of living resources and their habitats. This action plan briefly discusses the nature and extent of some of the major threats to these resources, and offers recommendations for their protection and enhancement. Although certain long-range actions are prescribed, the focus of the recommendations is on short-term actions, with measurable results, that the Massachusetts Bays Program can initiate or support during the 1991-1993 phase of the CCMP development and implementation process.

Overview of Issues Affecting Living Resources & Habitats

The estuarine and marine resources of Massachusetts and Cape Cod Bays are at risk from a variety of coastal and upland development activities and pollution. These risks are briefly described below in terms of habitat loss and degradation.

HABITAT LOSS

Massachusetts is estimated to have lost more than 20 percent of all tidal wetlands (salt marsh, tidal flats, barrier beaches, and rocky shores) existing at the time of the Colonists; estimates for salt marsh losses are considerably higher (CZM, 1991). Despite the passage of the Wetlands Protection Act (WPA) and Wetlands Restriction Act, ***incremental*** losses of coastal and inland wetlands continue. Wetland losses occur from certain public projects (such as bridge construction) and private projects (such as road crossings) that are exempt from the WPA, and from small dredge-and-fill projects authorized by variance under the WPA. Farming practices that qualify as "normal maintenance and improvement" of agricultural land are also exempt from the WPA. State personnel are also aware of some small, illegal dredge-and-fill projects and suspect that many more go undetected (DMF, 1985).

The incremental loss of coastal wetlands to legal and illegal small-scale projects is difficult to document directly. However, the number of "Notices of Intent" submitted to local Conservation Commissions for construction or expansion of private piers and docks, for example, has increased in many coastal towns (Lickus et al, 1989). Piers constructed over salt marsh can prevent light from reaching the underlying plants, eventually killing them. Dredging operations can deposit sediments on surrounding plants and shellfish, causing damage or destruction by smothering (DMF, 1985). While no single project constitutes a significant threat, the cumulative effects of many such projects could have serious ecological implications. In addition, more and more development is occurring on marginal land adjoining wetlands, producing adverse effects on wetland habitat.

In addition to the incremental losses wetlands continue to sustain, many wetland areas have not recovered from the mosquito control practices of the past. Grid ditching, in particular, severely altered large tracts of salt marsh habitat, drastically reducing habitat and wildlife diversity. While this practice has been discontinued in favor of the more benign technique of Open Marsh Water Management, it is expected to take many years for some marsh areas to overgrow the grid ditches constructed in the past.

HABITAT DEGRADATION

While the incremental *loss* of wetlands habitat by encroachment continues to be a problem, a much larger and more pervasive threat to living resources throughout Massachusetts Bays is habitat *degradation* by point and nonpoint sources of pollution and by physical alteration.

Pollution of Habitat

The health of the estuarine and marine habitats of the living resources of Massachusetts Bays is intimately related to water and sediment quality. Pollution due to excess nutrients, pathogens, suspended solids, and organic compounds and other toxic contaminants can seriously degrade these habitats, resulting in a wide variety of adverse impacts on plant and animal species populations and diversity.

For example, excess inputs of nitrogen from sewage treatment facilities, urban runoff, boat wastes, and other human activities can adversely affect coastal habitat by stimulating the growth of both micro- and macroalgal species. Increased abundance of algae can limit the availability of light reaching eelgrass blades, resulting in loss of eelgrass beds that provide habitat for shellfish and other animals. Dense layers of macroalgae can accumulate in shallow bays, making the habitat unsuitable for shellfish and other invertebrates. Blooms of microalgae or masses of macroalgae can sink to the bottom, decay, and deplete oxygen in the water. Severe oxygen depletion can kill fish and shellfish. There is also evidence that excess nutrients promote, directly or indirectly, the survival of coliform bacteria, contributing to the closure of shellfish areas.

Increases in shellfish bed closures result in heightened fishing pressure on remaining open areas and on local agents responsible for shellfish management. The authority for shellfish management is primarily vested in local communities; however, local programs are often limited by state funding. Over the past 20 years, local shellfish management generally improved as a result of the technical and financial assistance programs administered by the DMF. Now, these programs are being severely undermined due to fiscal constraints at the state level. The expansion of local shellfish programs has increased the need for technical assistance from the state, but state funding for such assistance has not kept pace with the demand. In addition, classification of shellfish areas has taken precedence over technical assistance in assignment of DMF staff time.

Impediments to sound shellfish management at the local level include lack of consistent and reliable harvest data and lack of state oversight for management planning. Harvest data are essential for evaluating resource trends, setting quotas, determining economic value, and predicting future populations. Currently, data on commercial and recreational harvest are collected at the local level, using methods that vary from town to town. Information is often based on personal observations or estimations, which reduces its reliability.

Although the state formerly provided financial assistance to local shellfish programs, there has never been a mechanism to ensure effective management planning. The financial assistance program was simply a reimbursement program open to all coastal communities. Reimbursements were based on available funds at the state level ($300,000 to $400,000 annually) and expenditures at the local level. At one time, local communities were reimbursed for as much as 50% of their expenditures. In the state budget for fiscal year 1990, the financial assistance program was not funded.

Toxic contaminants in the water column and sediments also can impair the habitats and health of marine organisms. Impacts resulting from exposure to toxic contaminants have been documented in seabirds, marine mammals, and marine finfish and shellfish (NOAA, 1988). Potential sublethal impacts of toxic contaminants on birds and marine mammals include both indirect effects, such as altered habitats or food supplies, and direct effects from the ingestion of highly-contaminated food, which has been reported to cause reproductive impairment in waterfowl and seal lions (OTA, 1987). If some toxic contaminants are present in sufficient concentrations, they

can kill finfish and shellfish. One suspected cause of mortality in these instances is the crippling of the organism's nervous system. Sublethal impacts on finfish and shellfish include morphological, behavioral, physiological, and biochemical changes, and diseases. Fish exposed to elevated concentrations of some toxic materials have been shown to eat fewer or different organisms, be less active, and grow more slowly (OTA, 1987). Exposure to toxic chemicals has also been correlated with fin erosion, tumors, internal lesions, and skeletal abnormalities. Finfish and shellfish species may also be less resistant to certain infections or suffer impaired reproduction. Some of these effects may eventually result in organism mortality (OTA, 1987).

Ten years of monitoring data collected and analyzed by the Division of Marine Fisheries show Massachusetts inshore fish stocks to be declining rapidly. Drastic reductions have been observed in bottom fish landings of winter flounder, yellowtail flounder, and cod from 0 to 3 miles from shore. Three factors — overfishing, pollution, and habitat loss — are cited as the major reasons for the decline. According to DMF officials, toxic pollutants introduced into Massachusetts Bays waters may be causing adverse health effects in some fish species. Winter flounder in Boston Harbor, for example, have been shown to have a high incidence of liver cancer, other pathological lesions, and fin rot. Migrating species such as bluefish have been found to contain elevated levels of PCBs, which can adversely affect reproduction and metabolism. Since many of these species utilize estuarine waters for at least part of their life cycle, exposure to toxic contaminants in these waters is implicated as a leading cause of their decline.

While toxic pollution is cited as one of the leading factors for the decline, *overfishing* is considered to be the principal cause. Fish that were once abundant in nearshore waters, such as cod, are now caught commercially only offshore. This has placed greater pressure on offshore stocks, and, as a result, the offshore fishery is in decline. According to a recent report by the Offshore Groundfish Task Force (1990), New England groundfish landings are at all-time lows due to heightened fishing pressure and inadequate management. Long-prized cod, haddock, and flounder, the foundation of the Massachusetts fishing industry for centuries, are losing their place in the marine ecosystem to dogfish and skates, so-called "rough" species that have very limited commercial value.

Loss of habitat is the third critical factor. The destruction and degradation of salt marshes, tidal flats, and eelgrass beds have resulted in the loss of primary spawning and nursery grounds for flounder and other species. These habitat losses have exacerbated the declines in fish stocks due to overfishing and pollution, and are contributing to the diminished viability of the region's commercial fishing industry.

While federal and state water pollution control programs have resulted in reductions of some toxic pollutants in municipal and industrial discharges, future urban and industrial growth in coastal areas could offset these reductions. In addition, although direct discharges of some wastes through pipelines and dumping are coming under increased control, nonpoint sources of toxic chemicals from stormwater runoff and atmospheric deposition may persist as serious problems for some time.

Improved protection and management of the living resources and habitats of Massachusetts Bays will require a better understanding of the sources, transport, fate, and effects of contaminants within the marine environment. Ongoing research sponsored by the Massachusetts Bays Program, the MWRA, the US Geological Survey, and MIT Sea Grant is beginning to shed light on the principal sources of nutrients, organics, and other contaminants entering the Bays, as well as on the circulation patterns and the modes by which nutrients and contaminants are transported, deposited, and transformed biologically.

Physical Alteration of Habitat

Just as pollution can degrade the habitats of living resources, *physical alterations* may be harmful

as well. Examples of physical alterations include hydrographic modifications, dredged materials disposal, shoreline construction, and upland development and sea level rise.

Hydrographic Modification. Alteration of certain hydrographic factors such as freshwater inflow and sediment loading can have significant impacts on the functioning of estuarine and coastal ecosystems. For example, the recruitment of many fish and shellfish stocks is closely linked to the hydrodynamics of estuaries and associated coastal waters. Changes in hydrographic conditions can result in changes in the production, composition, and abundance of phytoplankton, and reduction in the abundance and extent of desirable rooted aquatic vegetation such as eelgrass. These changes can be associated with decreased dissolved oxygen and light penetration. Such alterations can be detrimental to the production of estuarine-dependent organisms through shifts in food resources and changes in the availability of suitable habitat (NOAA, 1987).

Decreases in freshwater inflow result in increased salinity levels within an estuary. This in turn may result in a loss of the area as a nursery ground for certain fish species and other organisms whose tolerance for saline waters in early life stages is low. Many of the forage organisms associated with estuarine waters cannot tolerate increased salinity levels. Spawning areas for anadromous fish species such as alewife, shad, striped bass, and blueback herring, may be lost if freshwater inflow is sufficiently restricted.

Even more detrimental to anadromous fish populations are physical barriers, such as dams and highways, constructed across rivers and streams used as spawning runs. Highway construction can impede freshwater inflow into estuarine systems. Small feeder streams can be filled and dammed, inhibiting natural flow and permanently removing upland waters as anadromous fish spawning areas. Culverts used beneath highways in place of natural streambeds can constrict flow and thus increase water velocity enough to prevent the passage of fish upstream.

Materials carried into estuaries by river flow, and the plankton within the estuary, are two important food sources for fish. During spring and fall, peaks occur in both sources that coincide with migratory fish movements. The construction of dams on rivers can reduce the amount of freshwater flow into estuaries by evening out the flow over time, and thus reduce the seasonal "flood" cycle and amount of food available during fish migration (CZM, 1977).

Increases in freshwater inflow to estuarine systems may also have adverse effects. Increases in freshwater inflow can result from increases in highway pavement and other impervious surfaces. Runoff from these surfaces adds more freshwater to the system, and may carry oil, heavy metals, and other pollutants. A change in the salinity regime can cause changes in resident species composition, which in turn can cause changes in the organisms which feed upon them. For example, reductions in salinity (of less than five parts per thousand in some cases) can result in a loss of bay scallops and smaller molluscs. If salinity changes are sustained, the loss of molluscs may result in a decrease in fish such as winter flounder (CZM, 1977).

Changes in freshwater input, dredging, other coastal construction activities, and upstream land development and agricultural practices can all increase suspended sediment loads. Increased sediment loads can have negative impacts on marine and estuarine habitats through shoaling, which can reduce the volume of an estuary and result in a decrease or change in habitat (such as the burial of oyster cultch materials). Increased suspended sediments may also affect primary productivity due to its effect on light attenuation. In a study of the Delaware Estuary (Pennock, 1985), an inverse relationship was found between suspended sediment loads and chlorophyll concentrations. The study concluded that the predominant physical factor regulating phytoplankton biomass in the estuary was suspended sediment concentration.

Dredging and Dredged Material Disposal. Dredging and the disposal of dredged material can have significant impacts on the health of estuarine and marine organisms. Dredging is necessary to periodically clear harbors and bays of accumulated sediment. Most dredging activity

in Massachusetts is maintenance work, designed to retain the width and/or depth of existing navigation and shipping channels.

Two dredging methods—hydraulic and mechanical—are used. Hydraulic dredging uses a centrifugal pump which picks up a slurry of bottom material and water, and transports it through a pipeline to either the disposal site or a vessel which will carry it to a disposal site. This method is used primarily for onshore or nearshore disposal and is employed when the spoil is used for beach nourishment or dune creation. Hydraulic dredging has not been used extensively in Massachusetts.

Mechanical dredging is the more common dredge method in Massachusetts because many of the dredging projects in this state involve removal of bottom material that is unsuitable for beach nourishment or dune creation and must be ocean dumped. Mechanical dredging is similar to earth removal, using large bucket scoops or shovels that lift the dredged material in a consolidated form and place it in a barge or scow. The material is then transported to offshore disposal sites where it is deposited by opening doors on the bottom of the scow.

Dredging poses a threat to living resources in that it removes organisms that live both on and within the sediments. This reduction in the number of organisms may lead to a decrease in the diversity of species with subsequent impact on dependent marine resources. Dredging also removes benthic vegetation such as eelgrass which is used by the bay scallop for attachment and growth, by young eels and sculpin for protection from predators, and by brant as a major food source.

Adverse effects of dredging activity are more pronounced in areas where water circulation is limited and where the bottom is rich in organic matter. Problems are also exacerbated when the sediments are polluted with heavy metals, and salt marshes are situated nearby. Dredging activity in biologically-productive areas, such as salt marshes and related tidal flat systems, can cause significant reductions in productivity. For example, in estuarine environments, dredging can cause changes that exceed the tolerance levels of the resident organisms (CZM, 1977).

Mechanical dredging generates more suspended material at the dredge site than does standard hydraulic dredging, and impacts an area larger than the immediate site. As the shovel/scoop is raised to the surface, spillage may occur. This suspended sediment can have adverse impacts. It makes the water turbid and can cause the death of organisms by blocking the light necessary for photosynthesis and by clogging the gills and siphons of fish, molluscs, and other marine fauna.

Disposal of dredged material can pose a threat to marine organisms. In Massachusetts, dredged material is typically disposed of at sea. While some material is clean and can be disposed of with little impact, many harbor areas contain contaminated materials which could adversely affect marine organisms if not disposed properly. At the present time, Massachusetts does not have a management plan that addresses the long-term environmental impacts associated with dredged material disposal. The Office of Coastal Zone Management (CZM) has requested that the New England Division of the Army Corps of Engineers conduct a comprehensive study of the problems associated with dredged material disposal along the entire Massachusetts coast. Funds for this study have not yet been appropriated.

Coastal Construction and Recreation. Shoreline construction and recreational use of beaches and estuarine waters can degrade or disturb important habitat. For example, habitat loss and degradation, and disturbance by humans and domestic animals, are cited as major causes of the current downtrend in the Atlantic Coast piping plover population (USFWS, 1988). The wide, flat, sparsely-vegetated outer beaches preferred as habitat by the piping plover are a highly transitory habitat, dependent on natural forces for renewal and susceptible to degradation by human activities. Coastal development and shoreline stabilization projects (e.g., jetty and breakwater construction and dune plantings) may impede the natural forces that renew the beach habitat. Sand deposition, for example, may be interrupted by jetties and breakwaters, and

protective structures and planted vegetation may prevent storms from reshaping dunes in a manner optimal for nesting success. In addition, pedestrian and off-road vehicle traffic during critical nesting periods may crush eggs or fledglings, and free-running domestic dogs and cats may cause nest failure (USFWS, 1988).

Nesting populations of colonially-nesting herons, terns, and eider ducks on the Bays islands are also in decline due to habitat alteration and human disturbance. In addition, certain solid waste management practices (landfills, uncovered beach trash receptacles) are supporting artificially-inflated populations of herring gulls, which are outcompeting other marine bird species, such as terns, whose populations are threatened (S. Fefer, USFWS, personal communication).

Recreational boating activity, on the increase in Massachusetts Bays, may also contribute to the degradation of important habitat. Physical impacts may include erosion of shorelines by boat-generated wakes, increased turbidity due to resuspension of bottom sediments caused by propeller wash, or alteration of wetlands or eelgrass beds by the construction of boat launching ramps, piers, and moorings. Many embayments have seen large (but as yet unquantified) increases in the number of boat moorings and single-family docks and piers, with concomitant impacts on eelgrass beds and water clarity (CZM, 1991). Encroachment of boating facilities into wetlands and other significant resource areas may also pollute local waters through leakage and spillage of fuels and discharge of human wastes. The degree to which boat pollution adversely affects the estuarine environment depends in large measure on the intensity of boating activity, the size and flushing characteristics of the coastal water body, and the presence of other contributors of pollution. In narrow, constricted estuaries or embayments where water quality may already be approaching pollution threshold levels, intense boating activity on peak weekends may generate enough pollutants to produce adverse conditions, such as nutrient enrichment. Bays-wide, it is unlikely that recreational boating activity results in substantial biological or physical impacts when compared to other activities such as municipal or industrial wastewater discharge or dredged material disposal. However, in selected areas where intense boating activity coincides with high sensitivity of living resources to boat-related impacts, ecological damage may result (CZM, 1977).

Upland Development and Sea Level Rise. Valuable habitat may also be lost or degraded by sea level rise. A rise in sea level will have three major physical effects on habitat: shoreline retreat, increased flooding, and landward movement of salt water. Shorelines will retreat because very low land, such as tidal flats and salt marsh, will be inundated and other land along the shore will erode. Those coastal areas not lost to rising sea levels will experience an increase in flooding due to higher storm surges, the movement of larger waves inland, and increased runoff due to a decrease in upland areas' ability to drain as a result of a higher water table. Sea level rise will cause changes in the patterns of sedimentation and marsh accretion, circulation patterns, biochemical cycles, and primary and secondary production which, in turn, affect living marine resources (NOAA, 1988). Of particular concern is the potential net loss of salt marsh, one of the world's most productive ecosystems and habitat for innumerable coastal and estuarine organisms. A rise in sea level could significantly reduce salt marsh acreage, with dire ecological consequences, unless steps are taken to preserve existing bordering upland areas from development. Once developed —whether for roads, housing, waste disposal, or other uses—these areas will be lost as potential sites for establishment of new salt marsh.

Existing Laws, Regulations, Policies, and Programs

Numerous laws, regulations, policies, and programs are administered at the federal, state, and local levels to protect the coastal, estuarine, and marine habitats of the Massachusetts Bays region. These include the Federal Clean Water Act, State Water Quality Standards, State Wetlands Protection and Endangered Species Acts, and local zoning bylaws and subdivision regulations, to name but a few. All of these have many effective components, and the efforts of agency and board personnel responsible for their administration have resulted in important gains in habitat protec-

tion and management through the years. The Wetlands Protection Act, for example, has eliminated the wholesale alteration of salt marshes that damaged or destroyed broad areas of coastal habitats in the past. Nevertheless, incremental loss and degradation of wetlands and other coastal habitats continues, the result of numerous small-scale coastal and upland development and pollution activities that fall through the regulatory net.

FEDERAL LAWS AND REGULATIONS

The protection of wetlands and other coastal habitats is governed at the federal level by several major statutes, the primary implementing authority for which is shared by the Environmental Protection Agency, the US Army Corps of Engineers (Corps), the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA), and the US Fish and Wildlife Service (USFWS). For example, the Federal Water Pollution Control Act (FWPCA) and amendments (Clean Water Act of 1981 and Water Quality Act of 1987) govern the disposal of municipal and industrial waste, including toxic contaminants, by pipeline discharge into coastal waters. Under the Act, publicly-owned wastewater treatment facilities and industries must meet the requirements of EPA or approved state-administered programs to be issued effluent discharge permits. The Act also includes provisions for the management of nonpoint sources of pollution, such as stormwater runoff, that can also degrade coastal habitats. Section 319 of the Act requires states to identify waters that cannot maintain applicable water quality standards without additional action to control nonpoint sources of pollution, and to establish programs for controlling these sources.

Section 404 of the Clean Water Act regulates the discharge of dredged or fill material into coastal waters. Proponents of such activities must first obtain a permit from the Corps of Engineers. EPA, the NMFS, the USFWS, and state agencies review these permit applications and provide comments and recommendations on whether the permits should be issued and under what conditions. The Corps then evaluates the potential impacts of the proposed activities on wetlands and other marine habitats in light of its regulations and the comments received. If the impacts are found to be significant, the Corps can deny the permit application, or require the project to be modified to minimize impacts. If no practicable alternatives are available and the project is in the public interest, mitigation can be required to compensate for environmental damage caused by the permitted activity. EPA has the authority to overrule the use of any disposal site included in a Corps permit application if it determines that the discharge would have an unacceptable adverse impact on shellfish beds, fishery areas (including spawning and brooding areas), and wildlife.

Section 404 is limited to the discharge of dredged or fill materials. Projects involving excavation, drainage, clearing, and flooding of wetlands are not explicitly included.

Section 10 of the Rivers and Harbors Act of 1899 requires permits from the Corps for dredging, clearing, and other activities that could obstruct the navigable waterways of the United States (waters below the mean high tide level, including tidal wetlands). Section 10 has served to protect tidal wetlands from activities such as dredging that are not explicitly covered by Section 404.

The NMFS and the USFWS also have legislative responsibilities to manage fish and wildlife resources and their habitats. The two agencies have common interests in some marine resources and their habitats in coastal and estuarine waters, and waters occupied by anadromous fish. The responsibilities of NOAA's NMFS relate primarily to management of marine fish and anadromous fish, conservation of certain species of marine mammals (whales, dolphins, seals, for example), and protection of endangered or threatened marine species. The responsibilities of the USFWS include, but are not limited to, management of migratory waterfowl, anadromous fish, and endangered species.

The Fish and Wildlife Coordination Act (FWCA) and the National Environmental Policy Act (NEPA) are the major authorities under which NMFS and FWS conduct marine habitat protection activities. The FWCA requires interagency consultation to assure that fish and wildlife resources are consid-

ered when determining the economic and social concerns of a proposed federal or federally-authorized project that controls, modifies, or develops coastal waters. The NMFS and USFWS analyze a wide variety of projects under the FWCA, including Corps dredge-and-fill permit applications.

While efforts are made by the various federal agencies to consult and coordinate on the protection of wetlands and the other coastal habitats, insufficient staffing hinders full agency interaction. EPA, the Corps, NMFS, and USFWS all lack the personnel and budget needed to thoroughly investigate all wetland activities or to cooperate fully with state and local conservation officials on habitat protection matters (T. Bigford, NOAA, personal communication).

STATE LAWS AND REGULATIONS

At the state level, Executive Office of Environmental Affairs (EOEA) has regulatory authority over impacts to wetlands and other coastal habitats. The chief statutory provision for preventing or minimizing adverse impacts is the Wetlands Protection Act, administered by local Conservation Commissions with oversight by the Department of Environmental Protection (DEP). Under the Act, any activity that would remove, fill, dredge, or alter any bank, coastal wetland, flat, marsh, barrier beach, dune, or swamp requires filing a Notice of Intent to initiate public review. Additionally, activities proposed within a 100-foot buffer zone around the specified areas that may affect these areas also require a Notice of Intent.

The Wetlands Protection Act provides protection for many coastal species, including state-listed rare (threatened or endangered) wetland wildlife species whose habitat has been identified and mapped by the Massachusetts Division of Fisheries and Wildlife's Natural Heritage and Endangered Species Section. In these areas, no short- or long-term adverse impacts from alteration of the wetland habitat of the rare species population is permitted, nor is replication of habitat permitted. A number of such areas have been identified and mapped on Cape Cod, for example.

The WPA also provides protection for non-rare wetland wildlife species. Alterations of their habitat are subject to strict performance standards. The Act sets performance standards for alteration of banks, lands under water, and some floodplain areas which support wildlife. However, the wildlife habitat value of the 100-foot buffer area around wetlands is not recognized by the WPA. Many wildlife species require a combination of wetland and adjacent upland habitat for foraging, breeding, and nesting. For example, the shores of coastal plain ponds are particularly important plant and animal habitat and receive no direct protection. Maintaining a natural vegetated buffer in these areas is essential to providing habitat for these species. The Act also does not provide protection for all vernal pools. There is virtually no protection for the vast numbers of vernal pools located outside the boundaries of wetland resource areas (Cape Cod Commission, 1991). In floodplains, only vernal pools located within the ten-year flood mark are protected.

In 1990, the Massachusetts Endangered Species Act (MESA) was passed. Implementing regulations are due to be promulgated by December 31, 1991. The Act protects designated significant habitat areas for endangered and threatened species—both plant and animal. Once designated, any alteration of a significant habitat will require a permit from the Division of Fisheries and Wildlife. The proposed alteration must not reduce the viability of the significant habitat to support the species for which the area was designated. Although the MESA is a significant step forward in the protection of endangered and threatened species, it is feared that habitat designation will be a time-consuming process that will take many years. In the meantime, important wildlife habitat will continue to be lost, piecemeal, to development projects that either encroach into wildlife corridors or preserve only isolated fragments of "open space" that are of little benefit to wildlife.

Two promising legislative measures have been proposed which together would help curtail the destruction of wetlands and certain bordering upland areas that provide valuable wildlife habitat. The first is an amendment to the Wetlands Protection Act that would implement a "No Net Loss" wetlands policy in Massachusetts. This policy would establish a hierarchical approach to wetlands protection, with primary emphasis on *avoidance* of losses first, followed by *minimization* of

unavoidable losses, and *mitigation* only as a last resort.

The second measure is the proposed Massachusetts River Protection Act. This legislation would establish a uniform statewide development setback of 150 feet from rivers and certain streams. (Existing densely-developed areas and landowner hardship cases could receive a waiver.) These mandated "no build" zones, or greenways, would benefit coastal wildlife by providing continuous corridors for migration and by absorbing pollutants from various nonpoint sources, such as stormwater, that could degrade coastal spawning and nursery areas.

LOCAL LAWS AND REGULATIONS

At the municipal level, protection of coastal wetland habitat is primarily the responsibility of local Conservation Commissions. Most Commission members take this responsibility seriously, and invest considerable time in attempting to properly review and act on Notices of Intent filed under the Wetlands Protection Act. Unfortunately, many Commissions lack professional staff, and their volunteer members are often ill-equipped to deal with the intricacies of the Wetlands Act. The Act and its associated regulations are complex, containing a number of areas where Commission members must make subjective judgments and interpretations. Current training of Commission members is on a voluntary basis through courses taught by the DEP on a random schedule. Many members never receive formal training in the provisions of the Act and its regulations, and rely exclusively on hands-on experience gained while on the Commission. Although such experience is valuable, it is not a substitute for formal instruction on the regulations and how to apply them. Without this instruction, the learning curve for a Commissioner can be lengthy, and when combined with the typical Commission turnover, often results in poorly informed Commissioners inadequately enforcing regulations that they do not fully understand.

Compounding this problem is the lack of accurate, up-to-date maps, scaled for local use, showing the locations of salt marshes, eelgrass beds, beach nesting sites, and other important coastal habitats that warrant special protection by the Conservation Commission and other local boards. Existing habitat maps are spread across a variety of local, state, and federal agency files (Conservation Commissions, DMF, DEM, DEP, USFWS, EPA, etc.). These maps vary considerably with respect to geographic setting, resource types (e.g., salt marsh, shellfish beds, rare and endangered species habitat), scale, format, and reproducibility. Accordingly, they are either unavailable or of very limited use to local decisionmakers.

The Regional Offices of DEP do not have adequate staff to review enough of the negative determinations on Requests for Determination Of Applicability (RDOAs) being made by the local Conservation Commissions. This is a concern because in communities where the Conservation Commission is inadequately enforcing the WPA, there may be significant numbers of inappropriate negative determinations. Once this negative determination is made, and if it is not caught by DEP, the wetland area can be filled or altered legally. Currently, DEP selectively reviews RDOAs with negative determinations where they believe there may be a problem. In some cases, a particular conservation commissioner or conservation agent who is unhappy with a negative determination made by the Commission may request DEP to review the case. However, because of staff limitations, the DEP review process tends to focus more on appeals of local conservation commission decisions by project proponents rather than RDOAs. Consequently, more attention is paid to catching *overzealous* enforcement rather than *inadequate* enforcement.

The Wetlands Protection Act Regulations and other state and local habitat protection measures are not adequate to control cumulative or secondary impacts on coastal resources. Most state regulations are based on a case-by-case review of individual projects, with little opportunity for reviewing projects in the context of other environmental impacts. Municipalities probably have the best opportunity to regulate cumulative and secondary impacts through such mechanisms as zoning, subdivision and site plan review, and health regulations, but they are hampered by difficulties in making changes in zoning (the "grandfathering" issue), lack of technical expertise, and lack of reliable, up-to-date information and maps on the coastal and estuarine habitats at risk.

Conclusions

The marine and estuarine habitats of Massachusetts Bays are of immeasurable value to the Commonwealth's citizens and to its native wildlife. These habitats are used by living marine resources for food, spawning, rearing, protection from predators, and other life history requirements. They also provide other valuable functions to humans, including erosion and flood protection, water quality control, aesthetic enjoyment, and wildlife and waterfowl utilization. The people who live along the coastline have long appreciated the Bays' natural wealth and have wrested a livelihood from its bounty. The "coastalwealth" of Massachusetts has provided the basis for the region's longstanding maritime tradition. However, the habitats and living resources on both the landward and seaward sides of the shore are showing readily apparent signs of stress. Despite past gains in the regulatory framework designed to protect these resources, polluted coastal waters, loss of essential wetlands, declining fish stocks, increasing shellfish bed closures, and declining wildlife populations and diversity all testify to the failure of present regulatory, management, and planning programs to keep pace with increasingly complex environmental problems. The future health and productivity of the Bays' resources will require new attention to their management needs.

Improved management of the Bays' living resources will require improved cooperation and coordination among environmental management agencies at all levels of government. Central to this is the need for ongoing technical assistance to local governments to help them work collectively to address the various land and water-based stresses to the Bays' ecosystem. This assistance should include, among other things: improved transfer of information (such as habitat maps) that is directly applicable to local and regional needs; increased technical assistance on pollution prevention, best management practices, and other resource protection techniques; and public education on the critical relationships between human activities, water quality, and the health of the Bays living resources.

Goals, Objectives and Strategies

GOALS

- Protect and restore the habitats and living resources in Massachusetts and Cape Cod Bays
- Protect and improve water and sediment quality
- Encourage pollution prevention and other environmentally and fiscally sound methods of treatment, cleanup, and disposal.

OBJECTIVE

- Improve regulatory and non-regulatory programs at the state and local levels to further protect living resources and their habitats.
- Identify and map important habitats along the Massachusetts Bays coastline.
- Assess the impacts of various contaminants upon the living resources of Massachusetts Bays.
- Reduce contaminants (nutrients, pathogens, and toxicants) entering Massachusetts Bays.

STRATEGIES

- Coordinate habitat-related activities of the various federal, state, regional, and local government entities to improve planning and decision making.
- Provide technical assistance and public education to local and regional officials regarding habitat protection and threats posed by sea level rise, stormwater, hazardous waste disposal, dredged material disposal, growth and development, and boat wastes.

- Support demonstration projects for a variety of habitat protection activities including mapping important habitats, restoring degraded habits, and remediating pollution impacts.
- Promote pollution prevention as a means to reduce contaminants entering the coastal environment.

Recommended Actions

The following actions are recommended to protect and enhance the coastal resources of the Massachusetts Bays region:

Massachusetts Bays Program will:

- Continue to fund research on the sources, transport, and fate of organic contaminants.
- Fund a risk assessment study to determine the relative importance of the various contaminants entering the Massachusetts Bays in terms of their impact on living resources and habitats.
- Produce a characterization report in 1992 which will incorporate information on living resources and habitats, as well as information on the sources, transport, and fate of contaminants and their effects on living resources in the Bays. This information will be collected from historical sources and will also incorporate the results of MBP-sponsored and coordinated research.
- Fund a living resources assessment to serve as a baseline for evaluating the effects of changes in water quality.

NUTRIENT LOADING

Massachusetts Bays Program will:

- Fund research relating to nutrient loading and nutrient-phytoplankton interactions.
- Develop a Bays-wide monitoring plan that will assess the impacts of nutrients and contaminants to the Massachusetts Bays ecosystem and will develop a strategy for implementation.

Regional Planning Agencies should:

- Assist municipalities in identifying nutrient-stressed embayments, developing critical loading rates, and performing watershed build-out analyses to estimate potential future loadings.

Municipalities should:

- Work cooperatively with neighboring communities to adopt strong and consistent water quality bylaws and health regulations.

COASTAL HABITAT PROTECTION

Massachusetts Bays Program will:

- Work with the Division of Water Pollution Control to strengthen Massachusetts' Water Quality Standards to benefit coastal habitats.
- Work with EOEA to pass No Net Loss wetlands legislation, Watershed Protection legislation, and River Protection legislation.
- Support the adoption of strong regulations to implement the recently-passed Massachusetts Endangered Species Act.

EOEA should:

- Support the development and dissemination of criteria to provide Conservation Commissions and shellfish constables with guidance on reviewing pier and dock construction for impacts on wetlands, shellfish beds, and other coastal resources.
- Approve and fund the long-range habitat research and monitoring agenda recommended by the EOEA Technical Advisory Group for Marine Issues (Appendix B).

COASTAL HABITAT MAPPING

Massachusetts Bays Program will:

- Support the Wetlands Conservancy Program's efforts to map and protect (via deed restriction) critical coastal wetlands in Massachusetts Bays communities.
- Through its Data Management staff, design and sponsor a coastal habitat mapping demonstration project. This project will collect and synthesize available habitat information for a selected geographic setting (e.g., embayment) and present it in GIS format at a scale suitable for local use.

EOEA should:

- Fund the implementation of the Wetlands Conservancy Program, including identification and deed restriction of sensitive wetlands, and protection of restricted wetlands at a level higher than that afforded by the Wetlands Protection Act, as provided for in the Wetlands Restriction Act.

COASTAL HABITAT RESTORATION

Massachusetts Bays Program will:

- Continue to support and publicize ongoing habitat restoration projects, such as the Massachusetts Environmental Trust's Belle Isle Marsh Study and Habitat Restoration Project (near Winthrop) and Post Island Marsh Restoration Project (Quincy), and the Corps of Engineers/MDC anadromous fisheries restoration initiatives in the Charles River.
- Continue to inventory degraded coastal habitat areas and identify appropriate programs to restore them.
- Work with the **US Fish and Wildlife Service (USFWS)** and the **Massachusetts Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE)** to restore anadromous fish runs in the Massachusetts Bays region.
- Develop a demonstration project to restore a degraded coastal habitat (e.g., salt marsh, sand dune, eelgrass bed, anadromous fish run).

SHELLFISH AND FINFISH

Massachusetts Bays Program will:

- Work with DMF to sponsor sanitary survey training sessions for local officials. These training sessions would educate shellfish constables and health agents on the proper techniques for identifying and evaluating pathogen inputs into critical shellfish areas.
- Seek the designation of Massachusetts Bays shellfish areas and other estuarine habitats as "Outstanding Resource Waters" (under the Antidegradation provisions of the Massachusetts Surface Water Quality Standards).
- Work to secure additional state funds for shellfish management programs to be carried out at the local level, overseen and guided by DMF.

The **Massachusetts Bays Program**, **EOEA**, **DMF**, and the **NMFS** should:

- Support fisheries conservation and management actions to provide for the recovery of depleted groundfish and pelagic stocks in the Massachusetts Bays region. Specifically, the **Massachusetts Bays Program** and the aforementioned agencies should assist the New England Fishery Management Council in developing and implementing fisheries management plans to rebuild stocks.

EOEA should:

- Work with the **Massachusetts Bays Program** to encourage the development of markets for under-utilized fish species to alleviate pressure on depleted groundfish stocks (cod, haddock, yellowtail flounder, etc.)
- Create a task force to address the technical, regulatory, and economic aspects of aquaculture development in Massachusetts Bays.

WILDLIFE RESOURCES

The **USFWS** should, in cooperation with the **Massachusetts Bays Program** and **(DFWELE)**:

- Identify important habitats for endangered species, anadromous fish, and migratory, wintering, and breeding birds in the Massachusetts Bays region.
- Develop management practices that will protect these important wildlife habitats.
- Disseminate habitat information to regional planning agencies and municipalities for incorporation into regional and local habitat protection plans.

The **US Fish and Wildlife Service** will:

- Sponsor public workshops to educate local officials about management practices and options for protecting important wildlife habitats in the Massachusetts Bays region.

The DFWELE should:

- Expedite the designation of habitats for state-listed endangered and threatened species.

STORMWATER MANAGEMENT

Massachusetts Bays Program will:

- Develop and publicize a demonstration project to inventory, map, and remediate polluted stormwater discharges in a community that is sustaining significant economic losses due to rainfall closures of shellfish beds.
- Work with DEP to help disseminate its "Nonpoint Source Mega-Manual" and sponsor public workshops to educate local officials about Best Management Practices and financing options for controlling stormwater runoff.

Division of Wetlands and Waterways should:

- Develop a stormwater management policy under the Wetlands Protection Act and Regulations.

Division of Water Pollution Control should:

- Develop a program for permitting stormwater discharges in critical habitat areas.

Municipalities should:

- Adopt subdivision regulations that require that Best Management Practices for stormwater runoff be incorporated in any new development project.

- Rank, according to priority, storm drains based on known or potential impacts on critical habitat areas (shellfish beds, spawning areas, etc.) and implement Best Management Practices to reduce stormwater pollution.
- With the Massachusetts Department of Public Works, work cooperatively to ensure that untreated stormwater is no longer diverted directly into coastal wetlands or waterways when existing roads are re-paved and/or upgraded.

Regional Planning Agencies, the DEP, and Soil Conservation Service (SCS) should:

- Continue to provide technical assistance to municipalities on the use of Best Management Practices to control stormwater runoff.

TOXIC WASTE MANAGEMENT

DEM and the Regional Planning Agencies should:

- Continue to provide technical assistance to municipalities on the establishment of household hazardous waste collection programs.

Municipalities should:

- Explore innovative ways to establish and fund programs to collect and properly dispose of or recycle household hazardous waste and used motor oil on a regular basis.

Industries that discharge directly into receiving waters or sewage treatment facilities should:

- Continue to reduce toxic wastes with assistance from EOEA.

  The Commonwealth's new Toxic Use Reduction Act will require a 50% reduction of hazardous wastes by the year 1997. The toxic waste minimization program should include an ***environmental auditing team*** available from EOEA on a consulting basis to help businesses and industries reduce their toxic materials usage.

BOAT WASTE MANAGEMENT

Massachusetts Bays Program will:

- Continue to support the development and dissemination of boater education materials, such as the "Environmental Guide for New England Mariners," to inform the Massachusetts Bays boating public of the location of pumpout facilities and of the boater's responsibilities in boat waste management.
- Evaluate the option of establishing a "No-Discharge Zone" in Massachusetts Bay, based on the work of the Buzzards Bay Project.

DEP should:

- Through its Chapter 91 permitting authority, ensure that new marinas or expansions of existing marinas (greater than 10 additional slips) have adequate pumpout facilities, waste oil receptacles (for recycling of waste oil), and trash disposal/recycling containers.

CZM and **DEP** should:

- Develop criteria to determine the adequacy of pumpout facilities in all harbor areas.

DREDGING AND DREDGED MATERIAL DISPOSAL

The **U.S. Army Corps of Engineers** should:

- Conduct the proposed comprehensive study of the problems associated with dredged material disposal along the Massachusetts Bays coastline.

EOEA, EPA, NOAA, and The Army Corps of Engineers should:

- Through the Dredging and Dredged Material Disposal Task Force, explore alternatives to ocean disposal of contaminated materials, including containment on site and nearshore and shoreline disposal, both for large federally funded dredging projects and smaller municipal and private dredging projects.

EPA should:

- Establish sediment quality criteria for contaminants in dredged material.

SEA LEVEL RISE

Massachusetts Bays Program will:

- Work with CZM and area educational institutions to determine the local impact of sea level rise.
- Incorporate sea level rise data into the **Massachusetts Bays Program** data base.
- Develop a public outreach program to promote public understanding of the impacts of sea level rise.

Municipalities should:

- Plan for the preservation of upland areas that saltmarsh and other coastal wetland habitats can reclaim as sea level rises.

  RPAs should provide technical assistance to municipalities on methods to preserve upland open space.

COMPREHENSIVE PLANNING AND GROWTH MANAGEMENT

Regional Planning Agencies should:

- Provide technical assistance to help communities plan for and manage growth in a manner consistent with critical habitat protection.

  An important first step would be to conduct a "build-out" analysis for each community (focusing initially on coastal communities) to identify critical habitat areas at risk under a community's current zoning scheme (i.e., its "blueprint" for growth).

  RPAs also should provide model regulations and bylaws, including wildlife bylaws, which recognize the values of, and work to protect, important habitat areas.

Municipalities should:

- Review and upgrade their full complement of regulatory, non-regulatory, and planning tools—comprehensive plans, zoning bylaws, watershed bylaws, subdivision regulations, health regulations, wetlands and floodplain bylaws, open space plans, etc. — to prevent further habitat loss and degradation.

AESTHETIC QUALITY

The beaches and nearshore waters of the Massachusetts Bays region are among the region's most important aesthetic, economic, and recreational resources. They are visited by tens of thousands of bathers, hikers, boaters, and fishermen annually. Unfortunately, unsightly litter and debris, other visible pollutants such as oil and sediment, and even algae (in particular, *Pilayella*) are combining to detract from the full use and enjoyment of these resources.

The aesthetic problems addressed in this section are, in many ways, inseparable from other critical issues addressed in this plan. For instance, oil spills, especially large tanker accidents such as those that occurred in Valdez, Alaska and Buzzards Bay, Massachusetts in 1989, adversely affect public health and living resource interests as well as the aesthetic enjoyment and use of coastal waters. While the issue of oil spills, slicks and discharges is addressed here as an aesthetic concern, this plan recognizes the much broader implications of oil in the marine environment.

This action plan briefly describes the nature and sources of pollutants affecting the aesthetic quality of the Massachusetts Bays coastline, and offers recommendations for their abatement. Although certain long-range actions are prescribed, the focus of the recommendations is on the short-term actions that the Massachusetts Bays Program can initiate or facilitate during the 1991-1993 phase of the CCMP development process.

Overview of Aesthetic Quality Problems

BEACH DEBRIS AND MARINE FLOATABLES

The Massachusetts Bays beaches serve as repositories for a broad array of litter and debris, most of it coming from land-side sources. Due to the complex, counterclockwise circulation pattern in Massachusetts/Cape Cod Bays and the Gulf of Maine, debris dumped on or near shore in Massachusetts tends to remain in nearshore waters. Debris generated elsewhere is shunted farther north in the Gulf of Maine (NEAq, 1990). Local beachgoers, in particular, are a major source of beach debris (A. Smrcina and F. Courtney, CZM, personal communication). COASTSWEEP '90, the latest documented annual beach cleanup campaign coordinated by CZM, collected some 30 tons of debris consisting of over 260,000 separate waste items. Of these, plastics and foamed plastic (i.e., styrofoam) were found to account for almost three quarters of the total items collected. The twelve most common debris items (the "Dirty Dozen") were, by number of items:

1. Cigarette filters	17.93%
2. Plastic pieces	9.22%
3. Styrofoam pieces	6.50%
4. Plastic caps and lids	6.22%
5. Plastic food bags and wrappers	5.29%
6. Plastic straws	4.54%
7. Plastic rope	4.45%
8. Paper pieces	4.34%
9. Glass pieces	4.17%
10. Other plastic	2.55%
11. Plastic tampon applicators	2.45%
12. Metal beverage cans	2.31%

This listing closely parallels recent beach debris statistics compiled nationwide by the Center for Marine Conservation (CMC), with several notable exceptions. Massachusetts, with its "Bottle Bill" requiring a deposit on all soda and beer bottles and cans, has considerably fewer of these items on its beaches. (Users are either carrying them out, or can/bottle collectors are retrieving them for their redemption value.) According to the CMC:

"*Nine states have enacted legislation to encourage beverage container recycling...Six states that participate in the beach cleanups have bottle bill legislation — Connecticut, Delaware, Maine, Massachusetts, New York, and Oregon. In all of these states, the quantities of bottles and associated goods reported [six-pack yokes, metal bottle caps, metal pull tabs] were lower than the national figure. None of the states that reported bottles and associated goods above the national figure has a beverage container law.*"

When the bottle bill went into effect, Massachusetts also required that six-pack yokes be made of degradable plastic. The requirement was strengthened in 1988 such that yokes must now pose no threat of entanglement to wildlife within 60 days. Anecdotal reports from the COASTSWEEP '90 volunteers indicated that many of the collected yokes were extremely brittle and tended to break apart easily upon handling. Some environmental advocates have questioned the long-term implications of so-called "degradable" plastics. Because the plastic polymers do not actually "degrade," but rather disintegrate, the resulting plastic particles persist in the environment, and are therefore subject to ingestion by marine animals. There is a call for the development of reusable, or at least more benign, alternatives to the disintegrating plastic six-pack yokes. Possibilities include reusable plastic holders similar to the paperboard holders used for beer bottles.

Topping the list of beach debris items collected during COASTSWEEP '90 were discarded cigarettes. Cleanup participants catalogued nearly 50,000 cigarette filters, and many collectors gave up counting and merely recorded their observations as "hundreds" and "thousands" when the task of tallying them became overwhelming. These items represent a significant eyesore in the coastal environment and may pose a threat to sea birds. According to the CMC, some 50 species of sea birds are known to eat plastic, and many of the other 200-plus species may also, although they have not been observed doing so. The cigarette filter contains a polymer called cellulose acetate, which is estimated to survive approximately four years in the environment.

"Floatable" debris is also unsightly and a threat to marine organisms. Fish, birds, marine mammals, and turtles can ingest floatable debris — often with dire consequences — or become entangled in it. Floatable debris consists of an assortment of waste materials, the most abundant of which is plastic. The list includes plastic bottles, bags, and six-pack yokes; cups, plates, and utensils; fishing line, nets, floats, and ropes; and diapers, tampon applicators, and condoms. They originate from a variety of sources, including sewage treatment plants, combined sewer overflows, and storm drains; commercial and recreational fishing vessels (nets and other fishing gear, as well as general trash); and the general public (beach and roadway litter). According to the COASTSWEEP '90 survey, Massachusetts exhibited higher than average amounts of sewage-related debris.

Nevertheless, according to CZM officials, the news is not all bad. Indeed, some of the signs are positive. Although 30 tons of debris were collected during the 1990 cleanup campaign, this was significantly less, on a pounds-per-mile basis, than was collected the previous year. (In 1990, the average amount of debris per mile was 282 pounds, or 18 pounds per collector; the 1989 figures were 321 pounds per mile and 28 pounds per collector). Tampon applicators, one of the "Dirty Dozen" and a problem on Boston Harbor beaches in particular, dropped from 3.2 percent in 1989 to 2.45 percent in 1990. Scum removal systems installed at Deer and Nut Islands in 1989 by the MWRA are now filtering out most sewage-derived floatables (grease, paper, cellophane, condoms, etc.). According to the MWRA, 95 percent of all floatables are skimmed from the waste stream, then chemically stabilized and converted into a pasteurized, odorless, soil-like material. Much of the remainder is expected to be contained by a sludge-pelletization process due to come

on-line in December 1991 (sludge will no longer be dumped into Boston Harbor). The notable exception is plastic tampon applicators, which continue to survive the treatment process in large numbers. At present, no technology is particularly effective in removing these items from the waste stream (M. Connor, MWRA, personal communication).

The remaining and most significant source of sewage-related debris is discharges from combined sewer overflows (CSOs). Until discharges from CSOs are substantially reduced, marine floatables from coastal sewer systems will continue to be a problem.

OIL SPILLS, SLICKS, AND DISCHARGES

Boston Harbor and the Massachusetts Bays are a major transit route for tanker and barge traffic transporting heating and industrial oil and gasoline into the Greater Boston and northern New England markets. Oil enters the marine environment through a variety of sources, including sporadic tanker accidents (such as that of the *Global Hope* off Salem Harbor in 1978) and chronic small spills from vessel fueling, tank cleaning, bilge pumping, improper waste oil disposal, and stormwater runoff. A report by the National Academy of Sciences (NAS, 1985) estimated that 3.9 million metric tons of oil enter the world's marine environment each year.

Table IV-1. Oil Input to the Marine Environment

Source	Million Metric Tons per annum	% of Total
ACCIDENTS		
Offshore Petroleum	0.04	1.0
Tankers	0.39	9.8
Non-Tankers	0.02	0.5
NON-ACCIDENTS		
Offshore Production	0.01	0.03
Tanker Operation	0.71	17.9
Marine Transportation	0.82	20.7
Coastal Refineries	0.10	2.5
Industrial Discharge	0.20	5.1
Municipal Discharge	0.75	18.9
Urban Runoff	0.12	3.0
River Discharge	0.04	1.0
Ocean Dumping	0.01	0.3
Atmospheric Fallout	<0.50	12.6
Natural Seeps	0.20	5.1
Erosional Processes	0.05	1.3
TOTAL	3.96	100.0%

Source: Adapted from NAS, Oil in the Sea, 1985.

Oil spills foul beaches, boats, and fishing gear, and are life-threatening to marine plants and animals. Immediately after a spill, high organism mortality can occur and, for organisms that survive, stress and impaired metabolism are possible. Long-term impacts can ensue due to the persistence of hydrocarbons and residual toxic effects on individuals and, if the toxicity is pervasive, on populations.

If a spill occurs in a small, confined area so that oil is unable to escape readily, damage can be far heavier than in open areas. Prevailing winds can push oil into harbors and embayments where it

may be trapped and concentrated. Nearshore resource areas, including tidal creeks, shellfish flats, eelgrass beds, and bathing beaches, are especially vulnerable.

Response to the problem of oil spills generally falls into three categories: prevention, early response, and mitigation. As long as oil is used as an energy source, spills will not be eliminated. Therefore, we should pursue a dual policy of reducing the occurrence of spills and preparing to limit their damage. The number of spills may be reduced by mandating safety procedures and safety features on equipment used for storage, transport, and handling of oil.

The principal factor in minimizing environmental damage is speed of response. Oil spreads rapidly; begins to disperse through the water column, making cleanup efforts more difficult; and eventually contaminates sediments. Cleanup effectiveness diminishes over time as weathering disperses the oil. Most often, not more than 10-20% of the oil is recovered. The cleanup of the *World Prodigy* spill in Narragansett Bay, which was generally considered a very successful operation, collected only about 10% of the spilled product. In this spill, most of the lighter hydrocarbons evaporated, but substantial amounts entered coastal sediments, beaches, flats, and marshes. Without adequate technology to recover greater percentages of the spill, emphasis should be on prevention and speedy response. It is vital that the logistics be in place so that when an incident occurs, it is clear who to call, where equipment is located, and which cleanup methods are appropriate.

Commercial fishing vessels, which in the Massachusetts Bays region operate mostly out of Gloucester, periodically change their engine oil (10-120 gallons per boat). The inconvenience and expense (about 30 cents per gallon) of safely disposing of the used oil may result in a number of boat operators blatantly dumping oil into Massachusetts Bays waters. Although this is illegal, it is difficult to document violations and thus take enforcement actions against the offending fishing boats. Convenience and expense in disposing of waste oil may also be a problem for the general boating public, although oil changes in small launched boats are less frequent and of a smaller scale.

In general, Massachusetts Bays communities are ill-prepared to provide on-scene assistance during an oil spill or to protect sensitive resource areas. Uncertainty exists as to what equipment is available, where it is stored, and how it is to be deployed. Also, there is no formal inter-town coordination mechanism to maximize the equipment that is available within the various subregions of the Bays. Few drills or rehearsals are held at the town level, and local personnel have generally not received proper response training.

Regional oil spill contingency plans were developed for the Massachusetts Bays communities during the early 1980's, but these are sorely out-of-date and of limited value today. At the time of their development, they provided useful information on shoreline access points; oil transfer, processing, and storage facilities; environmental sensitivity maps; and available equipment and services. Similar information in updated contingency plans could be invaluable to the individual communities in developing their own contingency plans, and to DEP and Coast Guard personnel in implementing a timely response to a spill. The ability of local personnel to respond effectively in support of the DEP or Coast Guard could spell the difference between success and failure.

ALGAL FOULING (Pilayella)

Large masses of a planktonic (free-living) brown seaweed called *Pilayella* are regularly washing ashore and fouling the beaches of Nahant Bay and Broad Sound (MDC, 1990). Described by an MDC Task Force as a "gelatinous brown crud/slop," *Pilayella* constitutes a serious, and apparently growing, aesthetic and recreational problem in these embayment areas. The seaweed is unsightly, malodorous, and "repulsive" to touch, and is seriously impairing use of the beaches for bathing and beachcombing. Once confined to parts of Nahant Bay, it has nearly doubled in extent over the last decade and is now inundating all of the beaches in inner Broad Sound. It is

particularly offensive during warm periods when sand-covered portions of the material decompose anaerobically, giving off disagreeable hydrogen sulfide (rotten egg) odors. While *Pilayella* is not considered to be a public health threat, it is physically and aesthetically unpleasant. Even during minimal periods of beach cover by *Pilayella*, the shore is mottled and unattractive, especially when contrasted to the white and yellow sands of other beaches in the immediate area.

Various methods have been employed to remove the accumulated *Pilayella*, including the use of tractors equipped with a "York Rake" (belt rubber is fastened longitudinally to the inside curve of each rake to function as a massive squeegee). However, all the methods are expensive, time-consuming, and only temporarily effective in making the beaches presentable to the public. The by-product of the current beach grooming practices is essentially sand, with only a small percentage of the scraped-off mass represented by *Pilayella*. In excess of 1,000 cubic yards of beach sand can be routinely collected in just a three-day period. The costs associated with hauling this sand/*Pilayella* mix, disposing it at an offsite landfill, and providing replacement beach sand are exorbitant, making the current removal practices impracticable long-range management solutions.

Overview of Existing Laws and Programs

DEBRIS-DUMPING LEGISLATION

International and Federal

Several laws are in place to address the problem of marine debris dumping. On the international level, MARPOL (Marine Pollution) Annex V, an international law signed by the U.S. and 29 other nations, bans the dumping of plastics anywhere at sea. Nationally, the Marine Plastic Pollution Research and Control Act of 1988 forbids U.S. ships and ships in U.S. waters from dumping plastics, and sets minimum distances from shore for dumping of other types of debris, with civil penalties of up to $25,000 per case, fines up to $50,000, and imprisonment up to 5 years.

As with many other environmental laws, effective monitoring and enforcement of the debris-dumping laws are constrained by limited fiscal and personnel resources. Nevertheless, some enforcement action is occurring. The prosecution of the first penalty under MARPOL took place here in Massachusetts when a Liberian-registered vessel, the *Handymariner*, dumped dunnage (lining and packing materials that float) in Massachusetts Bay in August 1989. Fishermen from two Gloucester fishing boats observed the dumping; in fact, one of the fishing boats ran into some of the debris. The incident was reported to the Coast Guard; a patrol boarded the vessel, checked the debris disposal logs, and issued a citation. Early in 1990, the owner of the vessel was assessed a $12,500 penalty.

Other Coast Guard reports are being processed, and two general trends are emerging in the types of cases seen most commonly:

- Some fishing boat owners who are using nets of illegal mesh size are cutting away the nets when they realize they will be boarded by the Coast Guard. What the owners fail to realize is that the fine for dumping of plastic (netting, lines) is equivalent to the penalty for illegal nets: up to $25,000 in civil penalty, up to a $50,000 fine, and imprisonment up to five years.
- Some small party fishing boats are dumping used lines and crew wastes directly into the water. Passengers have reported several of these cases to the Coast Guard.

The Coast Guard does not routinely board for marine dumping inspections, but does include this review when boarding for other purposes. An owner of a vessel greater than 26 feet that does not have dumping information stickers prominently posted may be cited. All ships must also carry a log that lists disposal times, areas, and the types of materials dumped. If a vessel captain cannot show a legal dumping log or evidence of trash storage on board (i.e., after a trip across the Atlantic), the Coast Guard may make a prima facie case.

Provision has been made in the law for the awarding of bounties to persons reporting violations, but this has not been used as yet by the Coast Guard.

State and Local Legislation

Unlike ocean-based sources of marine debris, land-based sources are under the jurisdiction of state and local governments. Massachusetts General Laws Chapter 270, Section 16 forbids the throwing of any kind of litter in or upon Massachusetts coastal waters or within 20 yards of such waters. The overall framework for managing solid waste is provided in the Commonwealth's *Solid Waste Master Plan*. This plan establishes the following management hierarchy:

- **Source reduction**—Decreasing the amount of solid waste in the waste stream (10 percent reduction goal)
- **Recycling, reuse, and composting**—Of appropriate components of the waste stream (46 percent goal)
- **Incineration**—Of appropriate waste types (not to exceed 50 percent of the total)
- **Landfilling**—Of only those wastes that cannot be handled through the first three methods

While the *Solid Waste Master Plan* is a step in the right direction, its stated source reduction goal of 10 percent is considered by many environmentalists to be very conservative. A second shortcoming of the plan is that it fails to consider the special requirements of coastal areas, especially ports. The problem of marine debris begins, to a large degree, in these areas, necessitating special consideration by the Commonwealth's solid waste officials.

The 46 percent recycling, reuse, and composting goal set forth in the Master Plan, if reached, will help to reduce the total amount of material that must ultimately be disposed of. With regard to the plastic component of municipal solid waste (MSW), the *Plastics Recycling Action Plan for Massachusetts* provides an excellent framework for developing recycling programs. The plan sets a goal of 45 percent plastics recycling, augmenting the goals established in the *Solid Waste Master Plan*.

With regard to lost or abandoned (derelict) fishing gear, it is notable that current regulations under Massachusetts General Laws (Ch. 130, Sections 31-32) have been criticized for *discouraging* retrieval of such gear. As currently written, the regulations prohibit lost equipment from being retrieved without prior permission of the owner, and provide for a fine for violators. Only if the gear lacks identification marks (for the owner) can it be retrieved (Smrcina, 1990).

One final regulatory measure is of import with regard to the reduction of plastic products entering the local marine environment. As part of the court-ordered Boston Harbor cleanup effort, the MWRA is developing a *Combined Sewer Overflow Facilities Plan* to include a proposal for capturing and storing large quantities of excess sewage and stormwater from CSOs in the MWRA service area. This is notable because it should significantly reduce CSO inputs of plastics to Boston Harbor.

OIL SPILL LEGISLATION

The *Exxon Valdez* oil spill in Prince William Sound, Alaska in March 1989 and other major spill events resulted in Congressional passage of the Oil Pollution Control Act of 1990. The Act addresses a number of issues, including liability and compensation, vessel manning and training requirements, alcohol and drug screening, manning standards for foreign tankers, vessel traffic and communications systems requirements, and the requirement of double hulls for tankers. The Act requires the Coast Guard to maintain a computer file of available spill containment and cleanup equipment, and for the federal government to modify the National Contingency Plan. The Act also includes monies for oil pollution research.

The Oil Pollution Control Act of 1990 also calls for the establishment of Port Area Committees (PACs) and charges these committees with the responsibility to develop Area Contingency Plans (ACPs). PAC membership will include state and federal officials, local representatives, academia and others. Area Contingency Plans developed by these committees should address specific local areas including embayments in each "Port Area". According to the Act, each ACP shall, when implemented in conjunction with the National Contingency Plan, be adequate to remove a worst case scenario oil discharge and to mitigate or prevent a substantial threat of such a discharge. Although final regulations have yet to be promulgated, it appears that a Coast Guard representative will chair each PAC and as such, will be involved in drafting and reviewing the ACPs. Authority for final approval of the ACPs will likely be delegated to the Commandant of the Coast Guard (Lieutenant B. Hazelton, U.S. Coast Guard, personal communication).

Under the U.S. Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA), in effect since 1986, those who spill hazardous substances, including oil, must pay cleanup costs. The federal government and the states, in their roles as trustees, can claim damages for harm to natural resources.

In Massachusetts, oil spills are the responsibility of the Coast Guard and the DEP. The Coast Guard generally takes control over spills in marine waters, whereas the DEP is responsible for spills on land and small spills, such as those from moored boats. The Coast Guard has containment equipment for limited spills, but the primary response is by private contractors. The party responsible for a spill is liable for cleanup costs.

Both the Coast Guard and DEP have standing contracts with private firms to contain and clean up spills. Offshore spills are generally handled by the Coast Guard. If the spill cannot be contained with equipment locally available, a federal strike team is brought in. As a result of the Oil Pollution Control Act of 1990, the strike team for the Atlantic coast will be located in Fort Dix, New Jersey.

Conclusions

Beach debris, marine floatables, and oil discharges detract significantly from the aesthetic quality of the Massachusetts Bays coastline and can adversely affect the economy of the region's coastal communities. Despite recent positive trends in beach cleanup statistics shown in Coastsweep 1990, beach litter, marine debris, and oil in the marine environment continue to be persistent problems that impair public use and enjoyment of the Bays and can have far-reaching and long-term negative impacts on the region's living resources.

The extent of these problems and the apparent inability of current policies and regulations to effectively address them, requires changes to the region's approach towards minimizing the amount of debris and oil entering the Bays waters. New management options must utilize an aggressive combination of regulatory tools and public education that promotes pollution prevention as well as improved contingency planning for pollution cleanup. Central to this approach should be incentives that promote recycling, reuse and proper disposal of wastes before they can enter the Bays. The approach also should establish a framework for cooperation among levels of government and provide incentives for developing regional solutions.

Goals, Objectives and Strategies

GOALS

- Enhance the aesthetic quality of Massachusetts coast and coastal waters.
- Encourage pollution prevention and other environmentally sound methods of treatment, cleanup, and restoration.
- Protect and improve water and sediment quality.

OBJECTIVES

- Reduce the amount of beach debris and marine floatables in Massachusetts Bays.
- Reduce the amount of oil entering Massachusetts Bays.

STRATEGIES

- Increase public awareness of the beach debris and marine floatables problems.
- Promote recycling, reuse, or proper disposal of waste oil through public education and technical assistance to local planning.
- Increase capacity of coastal communities to plan for and respond to oil spills, slicks, and discharges at the local and regional levels.

Recommended Actions

The following actions are recommended as a means to improve the aesthetic quality and public enjoyment of the Massachusetts Bays beaches and nearshore waters.

BEACH DEBRIS AND MARINE FLOATABLES

Massachusetts Bays Program will:

- Promote public education on beach and marine debris problems, focusing attention on special user groups and their roles in keeping our coastal areas debris-free.

  These groups might include: the fishing and shellfishing industry; hunters (many spent shotgun shells have been found); recreational fishermen (used fishing line can now be deposited in waste receptacles in many tackle shops); beachgoers; recreational boaters; school students and youth groups; smokers and the cigarette industry.

- Support state legislation that would ban the sale of plastic tampon applicators.

Municipalities should:

- Install and maintain conveniently-located trash receptacles (with covers that cannot be easily removed by vandals and animals) at all public beaches, boardwalks, coastal parks, and other populated coastal locations.
- Provide educational panels or signs at these locations to inform the public about the problems of marine debris and the benefits of keeping our coast clean.
- Require the installation of collection/storage bins for glass, paper, plastics, and used oil at all marinas and yacht clubs to handle wastes from boats.
- Develop and adopt a "carry in-carry out" policy for public beaches.
- Ban the use of plastic food service materials at beach concession stands.
- Adopt bylaws that encourage re-use, source reduction, and recycling, while discour aging the use of "disposable" plastic products and packaging.

Municipalities with CSOs and treatment plant outfalls should:

- Develop and implement strategies for removing floatables from wastewater. Methods to achieve this include:

  (1) Installation and regular maintenance of screens on outflow pipes

  (2) Educational programs to inform the public not to dispose of plastics in toilets or storm sewers

OIL SPILLS, SLICKS AND DISCHARGES

Massachusetts Bays Program will:

- Support the efforts of CZM, the DEP, and Coast Guard to develop a mutual aid protocol that will govern the purchase and deployment of oil spill equipment by communities and businesses at the *embayment* level.
- Support the development of model regulations that will require boatyards and marinas to maintain oil containment and cleanup equipment on site.

  While it is appropriate that each community and marina maintain some kind of oil containment equipment, it is equally or more important for embayments as a whole to be able to respond to a spill. Local preparedness plans should require/encourage businesses (marinas, boatyards) and municipalities to work cooperatively to address their mutual spill response needs on an embayment basis. This would minimize duplication of effort, reduce equipment costs, and ensure compatibility of equipment and response actions.
- Support the examination of a deposit/refund system to encourage oil recycling and reduce the incentive to dispose of oil improperly on land or at sea.

U.S. Coast Guard should:

- Conduct training sessions for local response personnel on the proper use of oil spill containment and cleanup equipment.
- In its role as chair of Port Area Committees (PACs), ensure that the PACs review each embayment area's oil spill contingency plan for approval and inclusion into the Area Contingency Plan (ACP) and use those plans, as appropriate, in the event of an oil spill.

US Fish and Wildlife Service should:

- In cooperation with the Massachusetts Bays Program, National Marine Fisheries Service, and Department of Fisheries, Wildlife, and Environmental Law Enforcement, disseminate fish and wildlife habitat information for incorporation into embayment-wide oil spill response plans.

Coastal Zone Management Office (CZM) should:

- Provide technical assistance to Massachusetts Bays coastal communities in the development and update of embayment-wide oil spill contingency plans.
- Encourage the satisfactory completion of embayment-wide oil spill contingency plans.

Department of Environmental Protection (DEP) should:

- Conduct training sessions for local response personnel on *inland* spills to ensure local preparedness and coordinated interfacing between DEP and local officials.
- Enforce existing regulations requiring large retail facilities to provide used oil collection containers accessible to the public.

Municipalities should:

- Develop embayment-wide oil spill contingency plans
- Establish embayment-wide or other regional cooperatives for the purchase of oil spill containment and cleanup equipment.
- Adopt regulations requiring boatyards and marinas to maintain oil containment and cleanup equipment on site.

- Adopt design or performance standards for catch basins to remove oil, gas, and grease from stormwater.
- Establish convenient waste oil collection facilities to encourage oil recycling and reuse.

ALGAL FOULING (*Pilayella*)

Massachusetts Bays Program will:

- Define and coordinate the next steps to addressing the *Pilayella* problem in Nahant Bay and Broad Sound. This may include sponsorship of an appropriate pilot project on alternative *Pilayella* management and disposal options.
- Support a program to measure the biomass and map the areal extent of *Pilayella*.
- Support a program to assess the ecological impacts of proposed *Pilayella* management options.

WATERFRONT ACCESS: PUBLIC ACCESS AND THE WORKING WATERFRONT

"Many coastal landowners in Massachusetts have the same mindset as lakefront property owners. They worry about the public leaving litter on the beach, but some don't flinch at defacing sea cliffs with spray-painted "Private-Keep Out" signs, the graffiti of the privileged class." (M.E. Ross, Associate Professor of Geology, Northeastern University, in a recent Op/Ed article in the *Boston Globe*.)

Massachusetts has over 1,500 miles of coastal shoreline, yet only 363 miles are owned by, and accessible to, the public. The remaining shoreline is privately-held and unavailable for public use except for the narrow purposes of "fishing, fowling, and navigation" within the intertidal zone. This severely limits the public's enjoyment of many coastal areas at a time when the demand for additional recreational opportunities — swimming, fishing, boating, windsurfing — is rising.

Yet not all coastal resource areas can, or should, accommodate additional recreational use. Encroachment by boaters and beachcombers into certain sensitive coastal habitats, such as eelgrass beds and sand dunes, can have long-lasting adverse effects on commercially and ecologically-important fish, shellfish, and wildlife populations.

This action plan briefly examines problems relating to coastal access, including constraints on public use and enjoyment of the coastal zone and conflicts among competing waterfront interests. It describes the nature and sources of these problems, and offers recommendations for their solution. Although certain long-range actions are prescribed, the focus of the recommendations is on short-term actions that the Massachusetts Bays Program can initiate or facilitate during the 1991-1993 phase of the CCMP development process.

Overview of Access Issues

PUBLIC ACCESS

The Need for Coastal Access

The coastal zone has long been a valuable resource to the people of Massachusetts, 75 percent of whom live within an hour's drive to the shore. As our relationship to the sea evolves, economic dependence upon maritime activities has been joined by a new reliance on the shoreline for recreation and tourism. People in ever greater numbers are turning to the sea's edge for a multitude of reasons. Active recreation — swimming, fishing, and boating — is complemented by more passive forms, such as strolling along the waterfront, or gazing at waves and gulls. Visual access to the sea has taken on a new importance, as residents and visitors appreciate how the sweep of open water refreshes the eye and spirit, providing a welcome break from the rigors of our fast-paced, complex world.

Shortage of Coastal Open Space

Yet, as the demand for shoreline recreation grows, the supply of space available for future public use has dwindled. Growth rates in coastal towns such as Barnstable are among the highest in the state, sending waterfront property prices beyond the budgets of many municipalities. Even in today's stagnant economy, property lots with waterfront access can carry price tags in the hundreds of thousands of dollars. Constrained by the fiscal limits of Proposition 2 1/2, communities desiring to obtain coastal land for public use will need to pursue alternative approaches to direct purchase on the open market.

Beach Traffic Congestion

The shortage of public access to coastal land for recreational use takes several forms. Massachusetts is blessed with an abundance of beautiful sandy beaches, but these are not evenly distributed

along the coastline. Although 65 percent of the state's residents live north of the Town of Duxbury, 75 percent of the public beaches lie to the south of Duxbury. On any hot summer weekend, the demand for an attractive sandy beach within two hours of Boston is likely to exceed the supply. The crowded Boston area beaches prompt those with transportation to travel to other beaches on the north and south shores, or to Cape Cod. Many beach parking lots fill up before 10:00 a.m., effectively excluding those who live beyond a certain distance, or whose leisure time comes later in the day.

Public beaches designated as "public parks" may not charge discriminatory beach entrance fees for non-residents. Nevertheless, it is not uncommon to find *daily* beach parking fees for non-residents which exceed the *annual* parking fee for residents, or to have strict quotas on the number of out-of-town cars. In some communities, beach access is effectively denied by prohibiting or restricting nearby public parking on public roadways.

Historical Perspective: The Public Trust Doctrine

The shortage of coastal land for public enjoyment is a relatively new phenomenon in Massachusetts. Before the arrival of the English colonists, the inhabitants of the area were free to hunt and fish in coastal areas as well as inland. Private property rights were non-existent, and there were no bulky buildings to separate the water from the village.

The Colonists brought with them the English system of laws, including guarantees in the Magna Carta of 1215 that tidelands were in the public domain. This concept, the Public Trust Doctrine, dates back to Roman law, and was codified by Justinian in 529 A.D., in the following language:

"By natural law itself these things are the common property of all: air, running water, the sea, and with it the shores of the sea."

In 1641, the Massachusetts Bay Colony became the first colony to codify the Public Trust Doctrine in America. First, through the 1641 Colonial Ordinance, they guaranteed public access to Great Ponds. Then in 1647, they amended the Colonial Ordinance to extend private property ownership to the low tide line, to protect littoral property against the Crown's claims, and to thereby encourage private wharf construction and maritime commerce. They were careful, however, to safeguard public rights in the intertidal zone, and expressly reserved the public rights of "fishing, fowling, and navigation" in these lands. These three rights represented at that time the only significant public activities on the foreshore.

State Limitations in Providing Access

As a result of the Colonial Ordinance, Massachusetts has been limited in what it can do at the state level to carry out the wishes of the public and increase public access to the coast. Ordinarily a leader in coastal issues (Massachusetts was a pioneer in wetlands protection, and its federally-approved CZM program was the first on the Atlantic coast), Massachusetts lags behind other coastal states in providing public access to its beaches. California, for example, amended its state constitution to make its beaches public in 1873. Oregon did likewise in a State Supreme Court ruling in 1969, while Texas opened up its coast to the public in 1959. New Jersey recently followed suit, when its Supreme Court recognized public recreational rights on the foreshore, and even on the dry sand *above* high tide:

"The complete pleasure of swimming must be accompanied by intermittent periods of rest and relaxation beyond the water's edge."

In addition, several states, including California, Oregon, Florida, and Texas, have funded programs specifically to increase public access to the coast.

New Initiative: The Right of Pedestrian Passage

The Commonwealth is attempting to increase public access to the shore by obtaining the right of pedestrian passage along the intertidal zone. On July 10, 1991, Governor Weld signed legislation that calls on the Massachusetts Department of Environmental Management to select a beach along the coast to serve as a test case.

Massachusetts has traditionally exercised its control over land beneath the low water mark and reserved a public easement for purposes of "fishing, fowling, and navigation" between the high and low water marks in what are considered private tidelands. The new legislation expands this easement by stipulating that the Commonwealth may "take" the right for the public to walk along the intertidal zone. The big question now is how this easement will be valued—what will it cost the state, if anything, to obtain a public right of foot passage on the strip of wet sand?

The legislation limits access to daylight hours between sunrise to one-half hour after sunset (dawn to dusk), and to on-foot passage—no dune buggies or all-terrain vehicles would be permitted. In addition, provisions stipulate passage only — stopping to picnic, sunbathe, or play volleyball on private property would not be allowed, nor would any form of littering. Persons using this right-of-passage would be restricted to the wet sand area. Any travel across a section of private property to get to the intertidal zone would still be considered trespassing, a prosecutable offense.

The Commissioner of the Department of Environmental Management is responsible for selecting the test beach and implementing the provisions of the legislation, including determining the state's interest in the private land and filing an order of taking. Even when that is accomplished, the right to walk the intertidal zone may not be available until the courts decide the legality of the legislation and the level of compensation due the private property owner(s). Results will be very limited in the short run, but the new law has significant potential to expand public use and enjoyment of the water's edge in the long run.

The City of Boston is the first municipality in the Commonwealth to establish a public access policy and incorporate access into their local land use regulations by joining the Chapter 91 provisions for public access with the City's zoning laws. The new zoning, adopted in 1990, provides that the Boston Redevelopment Authority (BRA), the City's zoning administration agency, cannot make a proactive recommendation to the Commonwealth on whether or not a proposed project serves a proper public purpose unless such a project provides for public access to and along the water-front.

Loss of Historic Rights-of-Way

Many coastal communities have historic public rights-of-way to the water which have been lost over time, either through a lack of municipal vigilance or through deliberate concealment by abutting property owners. In some cases, the communities have failed to maintain accurate, up-to-date inventories of the public accessways that were incorporated into private land deeds, and over the years these paths have been lost through transfers of ownership. In other instances, abutting property owners have intentionally extended their lawns or driveways over the public ways, maintaining them in a manner indistinguishable from their own property — with one exception: they have not paid taxes on them.

Some communities have dealt with the problem of encroachment on recorded town ways by posting signs and providing additional maintenance, such as trash barrels and boardwalks down to the tidal zone. Other communities, seeking to avoid confrontation with abutting property owners, simply maintain a list of local town ways at the town hall, available upon request. This latter approach is often supported by residents, who argue that *they* already know where the town ways are, and that posting signs would only draw unwelcome visitors who would add to existing problems of cramped parking, vandalism, and littering.

The importance of maintaining accurate, up-to-date records of their town ways is not always immediately apparent to communities. In some areas, historic rights-of-way have been superseded by other accessways or by other waterfront uses. For example, demand for an accessway for fishing may have declined temporarily due to a deterioration of local water quality. Town ways which have become obsolete for one use, however, might be ideally suited for other uses. For example, in certain nearshore waters where shellfishing is now prohibited, windsurfing has become a popular pastime requiring public access to the water. Similarly, other light craft enthusiasts (canoeists and owners of small sailboats, aluminum skiffs, etc.) often seek safer, more sheltered launching sites than are provided at public motorboat ramps.

Some communities have been successful in locating and reclaiming their historic rights-of-way to water. The City of Gloucester, for example, completed an inventory of public landings along a two-mile stretch of its Inner Harbor. It accomplished this by examining property titles for evidence of municipal ways or easements, searching records of tax-exempt lands, and interviewing knowledgeable local persons, such as the Harbormaster, for anecdotal information on historical shoreline use. Through this process, the City established the existence of some 30 public ways to the water, including:

- 9 currently used, with title confirmed
- 15 used historically, so that title could be confirmed relatively easily
- 6 with uncertain title, which to be cleared requires research and possibly litigation

The Gloucester initiative revealed a number of cases where private encroachment had occurred on public ways, and recommended that the City either elicit payment from the private landowners or reclaim the ways for public use.

More recently, the Town of Rockport established a permanent town committee to identify all public rights-of-way and ensure their accessibility to the public. Supported by donations of time and money from a local volunteer group (Friends of the Rockport Rights-of-Way), the committee has identified, reopened, and is now preserving a number of previously "hidden" public pathways to the sea.

ACCESS AND THE WORKING WATERFRONT

Access, in the broader sense, extends beyond just the public recreation issue, and includes the issue of competing land uses along the waterfront. Commercial fishing, cargo shipping, boat yards, ferry services, fuel storage, and other marine industries are all vital port activities that provide economic benefits to the citizens of the state. These industries are facing increasing competition for limited waterfront space, not only from recreational users such as the boating public, but from a variety of non-marine-dependent interests: residential housing, hotels and restaurants, office buildings, shops. Since the public is not generally aware of the nature and role of the working port, they rarely advocate for the port's special industrial needs, such as off-loading and warehouse space, dredged shipping channels, and open turning basins (T. Whitmore, Massport, personal communication). Nor do they appreciate the port's importance to the regional economy. In 1990, the Port of Boston handled over 21 million tons of cargo (automobiles, hardware, petroleum) worth more than $8 billion. Over 8,400 workers were employed in jobs directly relating to the Port's maritime activities.

Encroachment of non-marine-dependent uses into Designated Port Areas (DPAs) can conflict with, and impair, a port's important maritime functions. These kinds of conflicts are not limited to just the larger ports, such as Boston and Gloucester, but are occurring in Designated Port Areas all along the Massachusetts Bays coast. Their resolution is far from a simple one. Nevertheless, an important new mechanism now exists to help the state and communities address these issues. In July 1990, the Department of Environmental Protection promulgated a new set of regulations to

implement changes made by the Legislature to Chapter 91, the Public Waterfront Act. The new waterways regulations took effect in October 1990. They contain numerous initiatives designed to enhance the state's stewardship of tidelands and other waterway areas, including the following:

- **Ensuring the immediate waterfront is used primarily for water-dependent purposes**—The new regulations include provisions to protect existing maritime activities from disruption by projects that are not water-dependent, and to promote the development of new facilities for water-dependent activity on the shoreline.
- **Supporting public/private partnership to revitalize waterfront**—The regulations support public and private efforts to revitalize unproductive property along urban waterfronts in a manner that promotes a mix of economically viable uses that incorporate public access and use and enjoyment of the waterfront.
- **Providing public access for use and enjoyment of the waterfront**—The regulations preserve public rights to walk freely on flowed and filled tidelands along the water's edge for, at a minimum, the purposes of fishing, fowling, and navigation. Furthermore, ample public access benefits will be secured where these lands are used for private, and particularly non-water-dependent, development.
- **Strengthening other state programs for shoreline conservation and utilization**—The regulations increase state protection of the aquatic environment, by imposing limitations on new fill and strict controls on structures along the water's edge and in Areas of Critical Environmental Concern.
- **Strengthening local controls and encouraging harbor planning**—The regulations encourage the active involvement of coastal cities and towns in licensing decisions and offer, through the development of a state-approved harbor plan, the opportunity to apply local height, setback, and other dimensional requirements to non-water-dependent projects.
- **Ensuring accountability to public interests**—The regulations will facilitate citizen participation in the licensing process by establishing procedures for notice, hearing, and appeal, and through coordination with Massachusetts Environmental Policy Act (MEPA) review. The regulations also establish a system for ensuring compliance, by offering existing users an "amnesty" period to obtain licenses for unauthorized facilities, and by substantially improving the enforceability of all new licenses.

A municipal harbor plan prepared by the City of Boston was recently endorsed by the Executive Office of Environmental Affairs. This plan is aimed at revitalizing several major segments of the City's shoreline, encompassing a multitude of water-dependent uses and providing waterfront access for the public. It is the first such plan to receive state approval under the newly-revised Chapter 91 regulations.

Conclusions

Burgeoning population in the coastal zone has led to increased demand for public access to and use of coastal areas in Massachusetts Bays. However, as demand for shoreline recreation (swimming, fishing, boating, windsurfing, etc.) has grown, the supply of accessible shoreline has dwindled. Shorefront development, transportation and parking problems, and loss of historic rights of way combine to limit opportunities for public access. In addition, the region's working waterfronts—the legacy of the Bay State's proud and longstanding maritime tradition and a major component of the region's economy—are being squeezed out by competing land uses in the region's harbors. New initiatives are needed to enhance public access and preserve traditional maritime uses in the coastal communities of the Massachusetts Bays region.

Goals, Objectives and Strategies

GOALS

- Improve access, education, and recreational opportunities in and around the waters of Massachusetts and Cape Cod Bays.
- Enhance the aesthetic quality of Massachusetts' coast and coastal waters.

OBJECTIVES

- Increase public access to the coast.
- Preserve traditional maritime uses of the coast.

STRATEGIES

- Provide incentives and technical assistance to help communities identify and reclaim historic rights of way to the water.
- Increase public awareness of public sites and recreational opportunities along the coast.
- Promote the development of harbor management plans that preserve the waterfront for marine-dependent uses.

Recommended Actions

Massachusetts Bays Program will:

- Sponsor the development of, and publish, a comprehensive guide of coastal public access sites in the Massachusetts Bays region.

  At present, individual communities, state agencies, and private, nonprofit land trusts publish access guides for the properties they own, but there is not a "one-stop" source of coastal access information available to a mass audience.

- Sponsor a review of the adequacy of boat landings along the Massachusetts Bays coast.
- Support the efforts of DEM to implement the Coastal Access Bill.
- Sponsor a "how-to" public workshop(s) for local officials on reclaiming and maintaining historic rights-of-way.

  Several communities, including Gloucester and Rockport, have established successful local coastal access programs, and could be invited to participate to share their expertise and experience.

- Co-sponsor, with CZM, a public workshop(s) for local officials on the development of embayment or harbor management plans and use of Chapter 91 regulations to increase public access.

Municipalities should:

- Re-establish and maintain historic public rights-of-way to the shore through appropriate legal means.
- Identify and protect sensitive coastal areas where public access and development should be restricted in order to maintain the integrity of sensitive natural resources.
- Develop embayment or harbor management plans that limit non-maritime-dependent development and promote public access to, and enjoyment of, the shoreline.
- Designate "working waterfront" overlay zones to preserve and enhance traditional maritime uses. Within these zones, boatyard preservation programs should be imple-

mented. All new buildings or accessory uses constructed within these zones should directly benefit maritime-related uses.

Coastal Zone Management Office should:

- Continue to provide technical assistance to communities on the development of harbor management plans and designation of "working waterfront" overlay zones.
- Continue to review and, where appropriate, reconfirm the Designated Port Areas.

CHAPTER V. THE MASSACHUSETTS BAYS PROGRAM UNFINISHED AGENDA

Planning For the Future

In April, 1990, Massachusetts Bays were designated an "Estuary of National Significance" and became part of a cooperative federal/state program designed to protect and improve water quality and enhance the living marine resources of the Bays. This designation was a significant milestone and represents an affirmation of the broad-based support for a long-term, comprehensive coastal protection program in Massachusetts.

As part of EPA's National Estuary Program, Massachusetts Bays is receiving funding to carry out an ambitious five-year agenda culminating in the preparation and approval of a Comprehensive Conservation and Management Plan in 1995. This Plan will identify lasting solutions to local, regional and bay-wide environmental problems. The Management Conference Agreement which was signed on November 13, 1990, states that the "ultimate goal of the Massachusetts Bays Program is to institutionalize the planning process." These words reflect the conviction that in 1995, when the Comprehensive Conservation and Management Plan is prepared and approved, it is not the end of the Massachusetts Bays Program, but a new beginning.

Between now and 1995, the Massachusetts Bays Program will identify near-term solutions to known pollution problems and to explore the means to carry out those solutions. One challenge facing the Program is to insure the continuation of the Management Conference or its analog beyond 1995 in order to carry out the implementation of near-term management recommendations, develop longer-term goals and activities, and provide continuity and coordination among the myriad of government agencies, academic institutions, and user groups that are working to protect and restore the Massachusetts Bays ecosystem. An equally complex challenge before the Massachusetts Bays Program is to establish a "coastal ethic" that can serve as the basis for the public's support of actions taken by the Program and others to protect and preserve the Bays.

In early 1991, the Massachusetts Bays Program drafted a five-year workplan to outline what must be done to institutionalize the planning process to establish a successful long-term coastal protection program. As a first step, the Massachusetts Bays Program established a Program Office at CZM to carry out the activities of the Management Conference and its participants. The Management Conference consists of four committees: Policy Committee, Management Committee, Technical Advisory Committee, and Citizens' Advisory Committee. Establishment of a Local Government Committee and Financial Planning Committee is under consideration. In conjunction with EPA Region I staff, the Program Office is working with these committees to develop annual work plans, distribute funds to carry out activities, produce specific products as directed by the committees, and provide leadership and logistical support to the Massachusetts Bays Program.

Secondly, the Massachusetts Bays Program recognizes that the cornerstone of an effective estuary program is its public participation program. Establishing a coastal ethic in Massachusetts will facilitate developing public consensus and political support to ensure long-term support and implementation of the management plan. Further detailed information on the public participation strategy of the Massachusetts Bays Program is provided in the section of this chapter entitled "Public Outreach Agenda."

Lastly, the Massachusetts Bays Program acknowledges that, in order to "institutionalize the planning process," it must work closely not only with other federal and state agencies, but more importantly, with local and regional government agencies in developing and implementing the management plan. Between now and 1995, the Massachusetts Bays Program will work to identify and evaluate funding sources to implement management recommendations; review and analyze the scope and effectiveness of existing federal, state, and local resource management programs to

identify gaps, target opportunities and identify the potential for leveraging funds; identify needed legislative and regulatory changes; and build regional and local capacity for pollution abatement and institutionalizing the work of the Massachusetts Bays Program.

Research Agenda

Shortly after the Massachusetts Bays Program was created in January 1988, the program's Technical Advisory Committee (TAC), consisting of area scientists from universities, government agencies, and private institutions, met to formulate a long-range research plan for the Bays. The goal of this plan was to provide data needed to fill the gaps in our incomplete understanding of the physical, chemical, and biological mechanisms which both drive and affect the Massachusetts Bays ecosystems. After a careful review of existing data and many hours of discussion, a research plan was developed that addressed five broad categories of research needs:

- Physical oceanography
- Contaminant sources
- Transport and retention of contaminants
- Bioaccumulation and biotransformation
- Social benefits assessment

The focus of this research plan is bayswide. Research at the local embayment level is supported as a separate program element (see p. V-17 "Embayment Management Strategies").

The Massachusetts Bays Program recommended that physical oceanographic and chemical assessment studies should receive the bulk of the initial funding, in order to lay the necessary groundwork for the biological studies that would follow in subsequent years. Because many of these initial objectives have been adequately addressed, the Massachusetts Bays Program recognizes that significant research investments must now be placed in biological processes, especially in areas that couple **living resources** concerns with our recently-gained knowledge of the Bays' physical oceanography and contaminant sources. In addition, the Massachusetts Bays Program recognizes that a long-term **monitoring** program is needed for the Massachusetts Bays region. While monitoring activities are separate from research activities per se, both initiatives have been designed to provide policymakers with the necessary environmental data to wisely manage and conserve the complex habitats of Massachusetts and Cape Cod Bays.

ONGOING RESEARCH

Prior to presenting the research agenda for 1991-1995, a brief synopsis of the studies that have been completed or initiated since the beginning of the Massachusetts Bays Program should be considered. This historical review will show that our current research agenda is both an outgrowth and a continuation of the directed research program initiated in 1988.

Physical Oceanography

An initial two years of physical oceanographic studies were funded by the Massachusetts Environmental Trust funds and have been continued into a third year. The objectives of these projects were to define the circulation patterns of the Bays on a seasonal basis, describe tidal flows and amplitudes, and determine the influence of wind on circulation. An additional product of this work would be the prediction of contaminant transport and retention probabilities in the Bays system. In addition to Massachusetts Bays Program monies, some of this work has been funded by the US Geological Survey (USGS) and the Massachusetts Water Resources Authority (MWRA). The USGS and MWRA have a three-year plan to continue their current research collaboration, including a substantial effort geared towards sediment transport and characterization, aimed at developing a three-dimensional hydrodynamic model for Massachusetts and Cape Cod Bays. In conjunc-

tion with this work, the MWRA has also funded biological oceanographic studies aimed at sediment nutrient flux, respiration, and primary productivity.

Contaminant Sources

A variety of studies, in various stages of completion, have been initiated to inventory existing point and nonpoint sources of contamination, with respect to both quality and quantity, in and around Massachusetts and Cape Cod Bays. Menzie-Cura and Associates (funded by MWRA) conducted the initial estimates of loadings for Boston Harbor. Metal contributions from the Merrimack River are being assessed as part of an MIT-Sea Grant project. Massachusetts Bays funds are being used to fund a Bays-wide source characterization study by Menzie-Cura and Associates. Three additional source characterization projects have been designated for funding during Phases 1 and 2 of the Massachusetts Bays Program:

- Analysis of organic loading from the Merrimack River
- Nonpoint source PAH loading measurements
- Atmospheric deposition analyses

A Request for Proposals (RFP) is currently being written for the first of these; proposals for the other two have been received and are under review. In addition, a risk characterization/assessment RFP has been promulgated.

Transport and Retention of Contaminants

The goals of this aspect of the Massachusetts Bays Program were to define the critical physical, chemical, and biological processes affecting the transport and retention of pollutants (both chemical and biological) in the Bays system. Initial projects funded included:

- A pilot study for a novel technique to track sewage sludge using elemental tracers
- The survival and deposition of persistent fecal indicator bacteria in sediment samples from Boston Harbor
- The seasonal distribution of nutrients and suspended solids in Massachusetts Bays

In addition, the joint MWRA-USGS research currently being conducted will address questions of transport of sediments and retention of metals. The MWRA is also planning to develop a model of nutrient transport and fate using data collected by MWRA and the Massachusetts Bays Program.

Bioaccumulation and Biotransformation

One of the goals of the Massachusetts Bays Program was to assess the potential for continued contamination of seafood, by elucidating the critical processes affecting contaminant bioaccumulation and biotransformation. This assessment would also serve as a first step toward evaluating impacts on ecosystem health. Due to the limited availability of funds, only a small project, focusing on bioaccumulation and biotransformation of PAHs in bivalves and marine worms, could be funded.

Social Benefits Assessment

The overall goal of this portion of the Massachusetts Bays Program was to develop appropriate management strategies based on uses, values, and use conflicts of Bays resources. A recently-funded project will develop a model to estimate social benefits of different pollution control strategies.

PROPOSED RESEARCH AND MONITORING

In addition to building on the five broad research areas discussed above, the Research Agenda for 1991-1995 will include studies on **Living Resources** and **Monitoring**. Both areas had been recognized early on by the Massachusetts Bays Program as needing support, but it was decided

initially to postpone implementation until a firm physical and chemical oceanography base could be established.

Proposed Research: Physical Oceanography, Contaminant Sources, and Transport and Retention of Contaminants

These three areas of concern are intimately linked. Both nutrients and PAHs are contaminants of major concern for the Massachusetts Bays system. With the completion of the Contaminant Source characterization studies described above, we should have a reasonable assessment of quantity of contaminant inputs to the Bays system. The Massachusetts Bays Program does not recommend committing additional resources to contaminant source characterization. However, the Massachusetts Bays Program does recommend that some funding be awarded for a limited characterization of organic contaminants in the sediments being collected by USGS-MWRA program, in order to complete the picture of accumulation of contaminants in the sediment. Due to the costs associated with organics analyses, this should only be done for a limited number of organic contaminants, after specific areas of concern are identified based on deposition rates, grain size, and inorganic contaminant inventories have been completed. Funding would be targeted for the 1992-1993 years. In addition, the Massachusetts Bays Program recommends that appreciable funding be provided in 1992, 1993, and 1994 for nutrient loading issues and nutrient-phytoplankton community interactions (biological oceanography) to address concerns about bayswide effects of nutrient inputs. These issues can more easily be addressed once the preliminary results of the physical oceanographic hydrodynamic model are made available.

Proposed Research: Bioaccumulation and Biotransformation

Substantial advances in our knowledge of bioaccumulation and biotransformation, beyond the present efforts described above, would require far more funding than is available through the Massachusetts Bays Program. The Massachusetts Bays Program recognizes that a significant amount of research in this area is being conducted both in the Boston area and throughout the country. The Massachusetts Bays Program supports efforts to integrate these studies and other information on risks and effects associated with contaminant exposure with the risk characterization/management components of the Massachusetts Bays Program (funded outside of the research budget). In addition, establishing a statewide toxics monitoring program (described below) and some aspects of the Mini-Bays Program (funded outside of the research budget) will partially address the bioaccumulation and biotransformation issues. Contaminant issues related to living resources will be considered under the **Living Resources** category below. The Massachusetts Bays Program therefore recommends only limited additional funding in 1992 and 1993 for **Bioaccumulation and Biotransformation.**

Proposed Research: Social Benefits Assessment

The Massachusetts Bays Program recommends that additional funding be made available in order to continue to support the development of a model to estimate social benefits of different pollution control strategies. These additional funds would be used to develop parameters and test the model, and to assess the success of regulatory/mitigation efforts. The Massachusetts Bays Program recommends that this funding be provided in the 1992 through 1995 period.

Proposed Research: Living Resources

Living Resources is an area that the Massachusetts Bays Program has identified as needing considerable support. Other than human health risks and aesthetic considerations, the ultimate impact of environmental degradation is on the living resources of the system. It is not enough to know loading and fates, we must begin to assess effects. Because of this, living resource issues are intimately linked with contaminant bioaccumulation and biotransformation. In addition, however, living resources issues also encompass areas such as habitat availability/suitability, food chain dynamics, disease processes, and life history traits. The primary goals of the **Living**

Resources program area is to identify critical living resources and to develop a strategy for protecting them. The Massachusetts Bays Program recommends that significant funding be provided for this initiative throughout the 1992 through 1995 period.

Proposed Monitoring

The Massachusetts Bays Program will conduct monitoring under the National Estuary Program agreement, which will not only assess impacts of contaminants, but will also determine the effectiveness of specific mitigation activities. The monitoring program will support the goals of the Massachusetts Bays Program, including protection of the habitats of living resources, protection of public health, and protection of water and sediment quality. Funds should be made available to design and implement a monitoring plan in 1994 and 1995.

OUTREACH AND EDUCATION PROGRAM GOALS

Over the next five years, the Massachusetts Bays Program will work to develop a new coastal ethic. It will do so by strengthening public values for natural resources to the point where citizens expect the environment to be protected and are willing to take the necessary steps to ensure this protection. It will foster a collective voice on issues throughout the region, and it will establish a regional consciousness and identity for the Massachusetts Bays. Outreach and education programs will be tailored to the CCMP Action Plan priorities of:

- Public health
- Habitat protection and enhancement
- Aesthetic quality
- Waterfront access

Public Outreach Agenda, 1991-1993

The Public Outreach and Education Agenda will bring positive attention to coastal issues, foster a sense of stewardship in those who use the coast, and, for those to whom stewardship comes naturally, accentuate the vested interest they have in the coast.

In addition, the program will encourage communities to use a proactive, resource-based approach to resource management and prevent pollution before it occurs. Pollution prevention complements the traditional reactive approach to natural resource management.

Because funding for the Massachusetts Bays Program will exist only for a limited time, an indigenous, grassroots infrastructure will be developed to provide a permanent constituency that can be enlisted for assistance, support, and participation in solutions to the problems and issues faced by the Massachusetts Bays Program.

Over the next two years, the Massachusetts Bays Program will educate people about threats to the Bays. The program will strive to eliminate complacency, initiate action on water pollution problems, and establish communication between municipal governments, de-emphasizing the limits of political boundaries in favor of embayment or watershed-oriented approaches to planning. The education programs, publications, and proposed actions will cultivate a new level of public awareness and involvement, empower those who are currently involved and concerned about pollution and environmental protection, and begin to create a new coastal ethic.

STRATEGY

The Public Outreach and Education Strategy is an integral part of the Massachusetts Bays Program. It supports and reflects all other facets of the program, including research, management, planning, and implementation activities. In addition, it links the CCMP Action Plan to a program that will build awareness, support, involvement, and leadership among program participants.

Successful implementation of the Action Plan requires public support that is best achieved through active participation. The public outreach and education strategy will maintain this driving force of public involvement through a soundly-designed structure of citizen advisors and local governance representatives. The strategy will identify targeted audiences and develop aggressive public participation and education campaigns that span the Massachusetts Bays region.

Structure

Citizens Advisory Committee. The mission of the Citizens Advisory Committee (CAC) is to represent the public in all phases of program development and implementation, and to ensure that the Management Committee and Massachusetts Bays Program (MBP) staff include the public in the decision-making process. The CAC will help with the following functions:

- Establish the MBP goals and objectives
- Recommend the most effective ways to inform the public and solicit citizen participation
- Identify key people and organizations that can help bring estuary-related issues to the public's attention and rally support for the program
- Advise on the allocation of funds for program activities
- Comment on research objectives
- Translate the research process and findings into non-technical terms
- Identify and educate targeted audiences
- Help develop implementation plans for the outreach and education portions of this program

The CAC will have representation on the Management Committee, the Technical Advisory Committee, and the Local Governance Committee. The Local Governance Committee will begin as a subcommittee of the CAC. However, it may evolve into its own entity. At that point, the Massachusetts Bays Program may wish to address staffing and budgetary needs, and revise the CCMP Public Outreach and Education Strategy accordingly.

Membership is open to the public and represents a broad spectrum of individuals, resource groups, education institutions, businesses, industries, and public agencies.

CAC activities are coordinated by a steering committee elected by and chosen from the CAC membership. The Steering Committee meets monthly to define and implement the outreach and education program goals, relay information to and gather feedback from their constituencies and the full CAC, and ensure that the mission and objectives are followed.

Local Governance. A goal of the public outreach and education strategy is to have a local governance committee structure in place by the spring of 1992. This committee will provide cities and towns with opportunities to participate in the development and implementation of the Action Plan, and to advise the Management Committee about local issues and needs. It will serve as a forum for communication between the management conference and municipalities, and will facilitate communication across municipal boundaries, and expedite the implementation of sound environmental programs for the protection and enhancement of Massachusetts Bays. Massachusetts Bays cover such a large region that involvement of local governments must be representative to be manageable. Over time these regional committees may change, but a two-tiered committee structure is proposed now:

Tier I - Regional Governance Committees

At the first tier, four or more regions will either participate through the formation of regional committees or through existing structures such as the four Regional Planning Agencies which represent communities along the Massachusetts Bays coastline.

The four or more regions will be encouraged to take an embayment-based approach when addressing water quality issues, with technical assistance and grants offered by the Massachusetts Bays Program. Issues will be identified that are caused by, or that affect, two or more communities. Those communities will be brought together for discussion and possible resolution of shared problems.

Tier II - Bays-Wide Governance Committee

A second tier will be established on a Bays-wide level. Representatives from the four or more regions will serve on this committee and choose a delegate to represent the local governments on the Management Committee. Through this membership, the local governments will take part in Massachusetts Bays Program decision making. The Bays-wide Governance Committee will serve as a forum for information sharing and discussion of Bays-wide problems. The Committee will have the responsibility of synthesizing the recommendations of the regional governance committees and relating them to the Management Committee to participate in Action Plan development and implementation.

Prior to forming local governance committees, a local governance contact/support person will be identified in each community along the coast. The contact/support persons will participate in the MBP by ensuring that their municipal boards are kept informed of Program activities, such as CCMP distribution and critique. Regional contact/support persons may be drawn from the CAC membership and/or Regional Planning Agencies or other appropriate organizations.

For example, when the CCMP is distributed to local governments, the contact/support person will ensure that it is received by each local board (e.g. selectmen/mayor/city council, board of health, planning board, conservation commission.) The boards will be asked to review and critique the CCMP in preparation for a regional meeting that may be hosted by a state senator or representative for that area. At those meetings, a full review of the CCMP will be conducted. Each municipality will be asked to vote to appoint a representative to a new Local Governance Committee or an existing regional agency as the Local Governance Committee. Thus, the LGC representatives will be chosen by municipal officials present at the regional meetings, illustrating the importance of local involvement at these meetings.

After a representative is appointed by each community to the Local Governance Committee, that person will be responsible for staying informed about MBP activities, keeping open a clear line of communication between MBP and the municipality, and attending LGC meetings.

Legislative Caucus. To effectively involve the legislators and congressmen that represent the Massachusetts Bays coastal residents, a Coastal Caucus will convene for formal discussion and information exchange on Bays-wide issues. Participating state and federal legislators will be asked to communicate with their constituencies about the goals and recommended actions, to encourage local support and involvement, and to initiate actions at the state and federal levels that further the goals of the program. This might include hosting regional meeting(s) in their area(s) for local governments, and participating in yearly briefings. The Coastal Caucus will be represented on the Management Committee by a chosen delegate.

Targeted Audiences

Targeted audiences are those categories of people in the public and private sectors who work in or around the Bays and depend on them for their economic, recreational, educational, cultural, or aesthetic value. Whether harvesting its resources, moving across or through its waters, disposing of wastewater, advocating for its protection, or studying its intricacies, any user of the Bays system should have a voice in the design of the comprehensive plan that aims to protect and enhance the Bays. Some of the targeted audiences will be:

- Recreational Users—yacht clubs, dive shops, canoe and kayak clubs, fishermen, bird clubs, waterfowl hunting associations, beach buggy associations, whale watching groups

- Business and Industry—marinas, commercial fishermen, shipping companies, ferry services, manufacturers, energy facilities, chambers of commerce, construction companies, real estate firms, unions, support services to water-dependent industries, business associations
- Government Bodies—local, state, and federal officials, regional planning agencies
- Educational Organizations—schools, universities, and student groups
- Citizen Organizations—environmental, farming, fishing, youth

By identifying and involving targeted audiences, the MBP will:

1) Ensure comprehensive review of the issues, goals, and action plans by all parties with an interest in the Bays.

2) Ensure that the information received by the various audiences addresses the impacts that their actions have on the Bays, and helps them fulfill their role to protect the Bays.

Comprehensive review of the issues, goals, and action plan recommendations by all targeted audiences is critical to the success of the Massachusetts Bays Program. In addition to the governmental involvement described above, businesses, educational institutions, and citizen organizations will play differing but crucial roles in the Plan's development. A formal structure may or may not be developed for these groups, but the importance of their participation cannot be overemphasized.

Business and industry, for example, should participate in order to fully understand any long-term implications the recommended actions might have on their operating procedures, costs, and permitting or regulatory requirements. Equally important, businesses should participate to inform the Massachusetts Bays Program of these implications, as well as their operational constraints and concerns. Business and industry are immeasurably important to Massachusetts, and the mutual interdependence of business on the environment, and the environment on business, requires that a balance be struck to keep both flourishing.

The MBP fully recognizes the difficulty in involving businesses during an economic recession, but feels their input is critical for their own sake, as well as for the environment. The CCMP will become state policy in 1996, and will therefore have long-lasting effects on the way businesses may operate in Massachusetts. Massachusetts businesses will be strongly encouraged to bring their insight, support, comments, and criticism to the table. Their involvement will undoubtedly prove invaluable to the success of the Program.

Educational institutions throughout the Bays area will be involved in the Massachusetts Bays Program as well. Their position in society allows them the unique opportunity to contribute to the expanse of knowledge on the issues surrounding the Bays, and, likewise, increase society's values for our natural resources. School curriculums, as well as programs and events, might reflect these issues, furthering the MBP goals of increasing public knowledge and awareness of the Bays.

Citizen groups will play a major role in the success of this Program: as advocates for environmental protection, they will support and encourage implementation of the action plan in their communities; as enthusiastic and enlightened residents, they will involve and educate their neighbors; as organized groups, they will reach many more people than would otherwise be reached. Citizen groups' interest, concern, and energy may carry the constituency for Massachusetts Bays through the next decade, beyond the life of the Program, toward a permanent voice for the Bays. Involvement in the Program, and review and critique of the CCMP by citizen groups is essential to long-term survival of the Bays.

Ensuring comprehensive review of the Action Plan requires that information is received by the

targeted audiences and that their role is defined. To streamline the process, the Massachusetts Bays Program will identify regional contact/support persons for each of the target audiences listed above who will distribute materials to their constituents or similar organizations in their area, and encourage their participation. Regional support persons will help ensure appropriate and timely dissemination of information. In addition, these people may be asked to host meetings in their region.

Support persons for business, education, and citizen groups may be asked by the Massachusetts Bays Program to distribute the CCMP to their board members and similar organizations in their area, and encourage their membership to read and critique it. The contact/support person may be asked to host a meeting inviting their members, constituents, and other similar organizations for full CCMP review.

To support these efforts, the Massachusetts Bays Program staff and CAC members will use an expansive database of names, addresses, and telephone numbers—categorized by audience—to provide for mass mailings. The recreational boating audience, for example, may need information on proper disposal of on-board septage waste, used motor oil, and trash; use of environmentally-safe boat paints and cleaners; and boater regulations. Local, state and federal governments may need information on pollution sources and remedies, the importance of the Bays for attracting tourism and business, and for enhancing fishing and recreation, as well as any opportunities for funding and legal and technical assistance that become available.

Public Outreach and Education Plan

The public outreach and education strategy will be accomplished in two phases. The first phase can be described as "network building." During the first two years of the program (1992 and 1993), emphasis will be placed on establishing working relationships between communities, citizens, businesses, and non-profit organizations. A commitment to support and participate in Action Plan implementation will be solicited, and other targeted audiences will be educated about the program. This phase will lay the groundwork for productive committee work, a clear expression of citizen responsibilities, and new opportunities available for implementation.

The second phase can be described as "expanding and strengthening" public support. The programs and activities are organized around six elements which are used in a variety of formats to most effectively achieve the Massachusetts Bays Program objectives. The committee structures (outlined above) will support these program elements by providing opportunities for citizen involvement and by bringing people together for discussion, information exchange, and coordination during Action Plan implementation. The six elements are mutually supportive, achieve the necessary repetition for learning, and combine to form an enlightening and entertaining package for the public to embrace. Highlights of these elements are listed below.

Plan Elements

1) Meetings—In order to mobilize the full CAC, the local governance committees, and the Massachusetts Bays citizenry, meetings will be held throughout the region to encourage participation in implementing the Action Plan. Meetings will allow for information and ideas exchange, program updates, identifying resources, and discussion of local issues, funding opportunities, and technical assistance. Non-profits, businesses, educators, state and federal agencies, and municipal and legislative officials will be represented.

2) Media Relations—Involving the press in the Massachusetts Bays Program is critical to its success. Meetings will be held with editorial boards and program directors of newspapers and radio and television stations to familiarize them with the Massachusetts Bays Program and encourage active coverage on Action Plan activities. Through press releases and talk shows, the Massachusetts Bays Program will help keep

media directors informed on Bay-wide issues. Special media programs and events might include a "Bays Trivia" program for radio shows, press cruises on different vessels representing water-dependent industries, and a television documentary about the Bays.

3) Action Programs—Grant awards will be made to citizens, organizations, and communities whose program ideas provide solutions to water-quality problems, create models, demonstrate innovative technologies, educate the public, incorporate an embayment or watershed-based approach to resource management, and contribute to developing a coastal ethic. Three grant programs are currently in place: Demonstration Project grants, Mini-Bays grants, and Bays Action grants. Technical support will also be provided to communities that are working to implement the Action Plan recommendations.

4) Publications—Informational materials will be produced and distributed to targeted audiences to publicize the goals, activities, and accomplishments of the Massachusetts Bays Program, and to increase public awareness about the Action Plan and public involvement in its implementation. The Action Plan topics of public health, habitat and living resources, waterfront access, and aesthetics will each be addressed through newsletters, brochures, fact sheets, posters, and progress reports.

5) Organizational—Maintaining and expanding the number of people involved in the Massachusetts Bays Program is critical to its success. This will be achieved most effectively with sound and timely communication. An in-house computer that stores mailing lists of targeted audiences, committee members, and the media for distribution of publications and correspondence will support this process, as will educational and scientific resources for public use, and telephone liaison with all committees and targeted audiences.

6) Programs and Events—By working cooperatively with other organizations and businesses, and by sharing and providing resources, the educational component of the Massachusetts Bays Program is strengthened. Conferences, symposiums, work shops, lecture series, video and slide presentations, and teacher training programs are all under the scope of programs and events. Each activity will address the four Action Plan issues of public health, wildlife habitat, public access, and aesthetics

It is important that CAC members, and especially the steering committee, actively participate in the planning and implementation of these outreach and education activities. It is the CAC's job to reinforce the program goals and ideals in outreach projects.

The local governance committees should be involved by ensuring that their respective jurisdictions have the information and technical assistance they need, and should take the lead in initiating action. This might include organizing workshops to address their region's concerns and implementing parts of the proposed Action Plan.

A strong effort will be made to involve non-profit environmental organizations in the program. The importance of these organizations lies in the interest and concern already within their membership. By working with citizen groups, the Massachusetts Bays Program can draw upon an established base of support, and span the entire region more efficiently than it otherwise could.

Financing Agenda

The Action Plan Chapter of this report identifies a number of actions that should be or will be taken between now and 1993 by the various levels of government concerned with protecting and preserving the water quality and living resources of the Massachusetts Bays ecosystem. Some of these actions are currently underway, others can be achieved without further financial resources.

But, there are some that will require additional funding at either the local or state level.

The identification and evaluation of funding alternatives for the Massachusetts Bays Program is set against a background of increasing costs for environmental protection and diminishing financial capacity at the federal, state and local levels. Nationwide, government spending for environmental protection is projected to increase by 37% between 1987 and the year 2000 just to maintain current levels of environmental quality. It has been estimated that an additional 38% increase will be necessary to meet the requirements of new regulations and standards.

The burden of funding environmental programs is also shifting. In 1981, local governments were already paying 76 percent of the cost of environmental protection (including air, water, solid and hazardous waste programs). By the year 2000, local governments will bear 87 percent of the public costs of environmental protection.

In Massachusetts, the current (and foreseeable) economic situation suggests that raising funds to pay for state and local initiatives recommended as part of the Massachusetts Bays Program will be extremely difficult. In today's political climate, new taxes are unlikely to be viewed favorably. In addition, a deteriorating economy further undermines the ability to raise revenues.

Between now and 1993, the Massachusetts Bays Program will establish the foundations for sound financial planning to implement management recommendations. In its FY91 Workplan, the Program has allocated funds to begin the process of developing financially sound and politically acceptable funding alternatives.

As a first step, the Program will arrange for a financial planning seminar (which has been offered as part of EPA's support to National Estuary Programs) to serve as a kick-off event for this effort. At the same time, the Program will establish a Finance Committee. This Committee should be composed of key stakeholders as well as representatives of state and local governments, regional planning agencies, members of the business community, members of the state legislature, local elected officials, and citizen's groups.

The Massachusetts Bays Program can benefit from the older, more established estuary programs regarding financial planning. In particular, the Buzzards Bay Project (BBP) prepared a Financial Plan as Volume II of its Comprehensive Conservation and Management Plan (May 1991). This Financial Plan is comprised of three components that, taken together, provide the basis for estimating costs and identifying funding sources for proposed actions. Much of the information contained in this Financial Plan is readily transferable to the Massachusetts Bays Program.

The first component of the BBP Financial Plan provides an evaluated inventory of potential funding sources to finance the recommendations for estuary protection and restoration through existing programs at the federal, state, and local level, or created through new initiatives at any of these three levels. This component is not a comprehensive review; it identifies only the most relevant revenue sources. Funding sources examined include grants and loans from federal and state sources, taxes, fees, fines, and private funding.

The second component presents cost estimation procedures and preliminary cost estimates for various management actions. The focus of this component is on those actions that may impose significant capital or operating costs on public or private entities in the Buzzards Bay area. Cost estimation procedures are presented for the following activities:

- Stormwater control
- On-site septic system improvements
- Boat pump-out facilities
- Oil spill containment equipment
- Toxic audit teams

The third component provides additional guidance to local governments on potential sources of new funding for recommended actions. This component reflects the fact that many of the actions recommended will be implemented at the local level, and that new and dedicated sources of funds are necessary to ensure successful implementation. The financial planning guidebook reviews six revenue options available to local governments, including general revenues, taxes, fees and charges, fines and penalties, bonds, and grants and loans. For each option, the guidebook reviews potential feasibility (e.g., the steps necessary to make use of that option and potential constraints on its use) and suitability (e.g., revenue potential, political considerations, equity issues, and administrative requirements).

In addition to revenue options, the guidebook covers four independent financial management mechanisms, including enterprise funds, bond banks, special districts, and revolving funds. These mechanisms can be used to facilitate access to a particular revenue option, or to manage the funds generated by one or more options, thereby linking the sources of funds to their intended uses. The guidebook includes examples of how the various revenue and institutional options can be applied to selected actions.

These three components establish the foundation for sound financial planning for implementation of the Buzzards Bay CCMP and will be transferred to the Massachusetts Bays Program as a first step to its financial planning effort. In addition, the Puget Sound Water Quality Authority recently published a paper relating its experiences with financial planning including the lessons learned both good and bad. This paper will serve as a background piece for discussion purposes as the Massachusetts Bays Program undertakes its planning process.

Financial planning as part of the Massachusetts Bays Program will evolve along with the first management plan. The overall goal of this effort between now and 1993 should be to better prepare Program participants to address the expected funding shortfalls to implement management recommendations. Hopefully, the steps outlined in this agenda will help the Program achieve this formidable goal.

Data Management Strategy

INTRODUCTION

The challenge of data management for the Massachusetts Bays Program (MBP) is to integrate and effectively communicate program findings about the effect of man's activities on the health of Massachusetts Bay and Cape Cod Bay. The links between natural resources and the pollution sources that surround them will be conveyed to decision makers and the public through summaries of research data and maps showing spatial relationships. Data will be represented in the context of watersheds and embayments in order to foster a resource-focused approach to problem solving around the Bays. These representations will support the Massachusetts Bays Program's Comprehensive Conservation and Management Plan (CCMP), public outreach efforts, and the Characterization ("state of the bay") Report by synthesizing research findings and illustrating the status and physical setting of Massachusetts Bays resources in easily-understandable forms. The CCMP, public outreach and education, and characterization efforts will support the goal of making Massachusetts Bays Program data accessible by providing a vehicle for disseminating information from the program.

Throughout the program, the Massachusetts Bays Program Data Manager will be a central point of contact for data compilation, adherence to policy, and education of data users and generators. The Data Manager's responsibilities for generating data products will evolve during the program according to capabilities and management priorities.

Data in the Massachusetts Bays Program includes two types:

- Geographic Data—including maps produced either by Massachusetts Bays Program or the Massachusetts Geographic Information System (MassGIS)
- Non-Spatial Data—including findings from research and monitoring studies

LONG-TERM GOALS OF DATA MANAGEMENT

The long-term goals of data management in the Massachusetts Bays Program are to provide pertinent data to managers, scientists, and the public so that informed decisions can be made to reduce pollution inputs and improve the management of resources around Massachusetts Bays. The goals are as follows:

1) Compile a data base of baseline information to:
   - Synthesize and interpret research results in order to characterize the state of the bay
   - Identify priorities for further research
   - Develop management plans
   - Inform the public of program findings
   - Design monitoring studies
2) Provide maps and data summaries for use in the CCMP, the Characterization Report, and other program documents. The Data Manager will also provide, with approval of the Massachusetts Bays Program Program Coordinator, products and assistance for public outreach, action/demonstration projects, and program planning efforts. As data management efforts evolve, an increasing amount of information will be available to the public.
3) Educate managers, scientists, other agencies, and the public about valuable data resources and effective information management techniques so that the data base and resources created during the existence of the Massachusetts Bays Program can be transferred to future monitoring, research, and planning efforts.
4) Comply with the OWOW (U.S. Environmental Protection Agency's (EPA) Office of Wetlands, Oceans, and Waterways) requirement of submitting data funded by the National Estuary Program (NEP) to the Ocean Data Evaluation System (ODES) data base.

These long-term goals will be achieved through short-term (1991-1993) objectives. The strategy must remain somewhat flexible in order to reflect changing program priorities and accomodate tasks that develop at different rates. The priorities and tasks will be reviewed by a Data Management Advisory Group (made up of program staff; committee chairs, or their designees, from the Management, Technical Advisory, and Citizens Advisory committees; and the Massachusetts Water Resources Authority (MWRA) Harbor Studies program). The Data Management Advisory Group will review the data management strategy annually to ensure that data management is responsive to the evolving needs of the program.

STRATEGY FOR 1991-1993

This strategy outlines the tasks and policies that have been developed to achieve short-term objectives from 1991 to 1993. It reflects the limited resources of the program and the fact that tasks develop at different rates. The rate of development, the scope, and the level of detail of each task will depend on the evolving priorities of the program, as well as the quality of existing data sets,

which will govern how much preparation is necessary to make them usable for program purposes. Therefore, the proposed tasks will reach different stages of completion by 1993. The short-term objectives are as follows:

- Create a Base Map—One of the primary tasks of the Data Manager in 1991 is to create a base map of the Bays on which bathymetry, pollutant sources, offshore geographic features, and drainage areas can be displayed with research findings. This map is important for characterization and public outreach because it will aid in illustration of spatial relationships among pollution sources and affected areas.
- Create a Data Base for Characterization—In 1992, the emphasis will shift to integrating, synthesizing, and presenting data from program-sponsored and historical research in order to characterize the "state of the bay." At any time, these activities will take priority over other tasks.
- Prepare an Index of Bays Information—Throughout 1991-1993, the Data Manager will design and oversee the development of an index of information about pollution sources, research programs, and natural resources for use by a wide audience interested in learning about the Bays.
- Assist Contractors, Process Requests for Data, Provide Graphics to Program—Throughout 1991-1993, the Data Manager will assist contractors, prepare graphics and data summaries, and fill requests for data on a limited basis according to program priorities (such as preparation of the CCMP or workshop presentations), and the approval of the Program Coordinator.

The Data Manager will address these goals with the actions described below.

ENTER MASSACHUSETTS BAYS PROGRAM CONTRACTOR AND HISTORICAL DATA INTO THE MASSACHUSETTS BAYS PROGRAM DATA BASE FOR CHARACTERIZATION

The purpose of research funded by the Massachusetts Bays Program is to provide baseline information to scientists and managers for characterizing the state of the bay and designing monitoring plans to assess changes that result from actions taken. The baseline information will come from a data base created from Massachusetts Bays Program-funded research and demo projects and historical research. The data from this research will be incorporated into the Massachusetts Bays Program data base for use in the Characterization Report. Since a significant portion of the Massachusetts Bays Program-funded research will be completed in early to mid-1992, and characterization must be finished by the fall of 1992, the Data Manager will review representative subsets of data from researchers in January, so that final versions of data sets can be easily incorporated when they arrive.

The data consist of a diverse array of information, and it would be labor-intensive to try to maintain all of it online. Therefore, data from Massachusetts Bays Program and historical research will be entered into the data base only if they are determined to be of priority for use in characterization. Data from program-funded research that are not entered into the system will be stored on floppy disks and in reports.

The Massachusetts Bays Program uses the same software (Arc/INFO Geographic Information System (GIS), ORACLE Data Base Management System (DBMS)) as that used by the Massachusetts Water Resources Authority, MassGIS, and the Buzzards Bay Project. The data base structure is identical to that designed for MWRA in order to ensure compatibility with this closely-related data base. This data base is also compatible with that of the Buzzards Bay Project.

PREPARE MAPS AND DATA SUMMARIES

The Data Manager will prepare maps and data summaries that are deemed to be priorities by the Massachusetts Bays Program Program Coordinator and Data Management Advisory Group. This work will include:

- Preparing data summaries for program publications
- Plotting data on maps for the CCMP, annual reports, meetings, workshops, and other presentations
- Integrating different data types for input into decisions

For example, maps of towns and drainage basins included in the Massachusetts Bays Program area have been prepared. Statistics for land use changes from 1971 to 1985 in each drainage basin have been compiled and incorporated into the 1991 CCMP. Selected Massachusetts Bays Program and historical research data will be plotted on maps in order to illustrate its geographic distribution and relationships with other data. Such illustration will be a key to conveying program findings and progress to the public.

Some of the maps and data summaries will require creation of new data in the GIS. The source data from which the GIS data will be developed must be quality-checked, made consistent, and formatted for GIS entry. The data types listed below are priorities that will be developed over time, including:

a) BATHYMETRY OF MASSACHUSETTS BAY AND CAPE COD BAY. This base map will contain bathymetry, place and feature names, and navigational features, and will be critical in providing context for research findings around the Bays.

b) WATERSHED BOUNDARIES FOR CAPE COD, PLYMOUTH, AND SELECTED EMBAYMENTS. These boundaries are essential to such tasks as calculating accurate estimates of pollution inputs to the Bays based on land use, population density, and other factors.

c) COASTLINE SEGMENTS. Segments of the coastline that are united by common characteristics (e.g., drainage basin/recharge area, embayment, uniformity of coastal features) will be defined to allow GIS analysis of discrete portions of the coastline. The Data Manager will work with the Data Management Advisory Group to define appropriate criteria for defining the segments.

d) MAJOR NPDES DISCHARGES. The Data Manager will locate the best source of NPDES permit locations and assess the feasibility of entering them into the GIS.

ASSIST CONTRACTORS (RESEARCH, ACTION/DEMO, MINIBAYS)

In order to ensure that contractors submit data that are compatible with the Massachusetts Bays Program data base, the Data Manager will:

- Provide data submission requirements to contractors prior to the start of work
- Assist contractors in submitting properly-formatted data from their work
- Ensure that data delivery is satisfactory before final payment is made on any contract
- Assist contractors with requests to acquire data relevant to their work

DESIGN AND IMPLEMENT INDEX OF MASSACHUSETTS BAYS

The Data Manager will design an index of data resources and information about resources, research, policy, and programs in the Massachusetts Bays area. It will be designed for use by interested members of the public, nonprofit organizations, students, scientists, and policymakers.

The Data Manager will hire and supervise an intern to compile the entries. The information could include: background/scope of the program, summaries of program findings, data sets, maps, reports, scientific papers, and the information necessary to locate sources not included in the index.

COOPERATE WITH OTHER AGENCIES AND PROGRAMS ON RELATED DATA POLICY, DEVELOPMENT, AND USE

In order to avoid duplication of effort and incompatibility of data among related projects, the Data Manager will maintain contacts and exchange data with local, state, and federal agencies conducting complementary work. In particular, the Data Manager will maintain contacts with other EOEA agencies, the MWRA, the Regional Planning Agencies, the National Park Service, U.S. EPA, and other National Estuary Programs (especially the Buzzards Bay Project, the Narragansett Bay Project, and the Casco Bay Project). Cooperation with these groups will assure integration of Massachusetts Bays Program data management with similar activities and enhance the work of the program. The Data Manager may also request or provide assistance to agencies working on themes of mutual interest. In addition, data in the Massachusetts Bays Program will be compatible with established format and quality standards of EOEA, MWRA, and the Buzzards Bay Project for creating GIS and tabular data.

Process Requests for Data and Information

The Massachusetts Bays Program aims to provide as much information as possible to the public and to other agencies in order to support public outreach and education, and to convey the findings and physical setting of program work. To this end, the Massachusetts Bays Program Data Manager is preparing a set of maps and data summaries that can be requested from the Program. Anyone (nonprofit organizations, government agencies, interested members of the public, and others) can request data by contacting the Data Manager. However, the availability of data and preparation of special data products (e.g., special theme maps, data from scientific research) is governed by the Massachusetts Bays Program Data Distribution Policy and will be carefully considered on a case-by-case basis. The Massachusetts Bays Program Data Distribution Policy is necessary because of the limited resources of the program and because access to different types of data is subject to different considerations. The final decision on providing data, and the exact form of the data to be provided, will be made by the Massachusetts Bays Program Program Coordinator.

FUTURE OBJECTIVES 1994 - 1995

In future years, data management activities will continue to address long-term goals with short-term strategies. These strategies will include the tasks of:

- Incorporating NEP-funded research into the Massachusetts Bays Program data base
- Submitting NEP-funded research data sets to EPA in Ocean Data Evaluation System (ODES) format
- Illustrating research findings on maps and in data summaries
- Providing data to decision makers
- Developing additional GIS data bases
- Assisting MiniBays projects with data development and submission
- Providing baseline data for designing the monitoring plan
- Transferring responsibilities of data management to long-term monitoring and implementation efforts

A future task recommended in the 1991 CCMP is to create a GIS data base that incorporates findings from a future living resources and habitats study. The focus of data collection and

synthesis in such a study could be a bay-wide inventory for monitoring and emergency response, or a detailed resource inventory of one or more embayments. In either case, the data should be collected and synthesized at a scale suitable for local use.

Embayment Management Strategies

The Management Conference Agreement of November 1990 identified two levels at which the Massachusetts Bays Program will function: "bays-wide and on an embayment level." The activities of the Program on the embayment level will involve working with local government and citizens groups to "develop and implement strategies for effective embayment management."

Land use management will be a major issue at the embayment level, with the Massachusetts Bays Program working to provide local managers with the tools to predict and minimize resource impacts related to land use. Shellfish bed protection and restoration, an issue of environmental, economic, and political concern, is intimately related to land use and will be one of the priority local management issues.

Over the next several years, the Massachusetts Bays Program will employ a variety of tools to facilitate implementation of water quality management strategies at the local level. These tools will include:

- Technical assistance and other staff support
- Research and monitoring
- Data management
- Funding action/demonstration projects
- Coordinating public outreach activities, especially at the local level

Specifically, the Massachusetts Bays Program will provide staff to offer technical assistance to communities, to write the CCMP and promote its recommendations at the local level, and to coordinate local governance committee activities.

Research and monitoring at the embayment level will investigate pollution-related problems in order to relate the effects of land use to pollution and to further our understanding on an embayment level of the sources, transport, fates, and effects of pollutants. Ultimately, this information could be utilized as the technical basis for bylaws/ordinances changes at the local level. One ongoing research project that may be of interest to local governments is a socioeconomic study which will increase current knowledge and understanding of the value and benefits of our coastal resources. The information generated will provide a baseline against which future improvements in water quality can be judged.

Data management at the local level may include development of GIS maps of local embayments, as well as building the Program's data base to include historical and newly-collected data. Ultimately, data management activities should assist decision making at both the state and local levels.

The Massachusetts Bays Program also will fund a variety of demonstration projects to illustrate the environmental and economic benefits of recommended management strategies by implementing corrective action to problems with identifiable or specific causes or solutions. One focus of this effort will be the Mini-Bays projects. The goal of this program is to find appropriate solutions to pollution-related problems that will achieve a measurable improvement in environmental quality. Such successful management models can then be transferred to other communities within the Massachusetts Bays area. Three embayments within the Massachusetts Bays study area have been selected to participate in this program. These embayments are Plum Island Sound, Fore River, and Wellfleet Harbor.

Also part of its demonstration agenda, the Massachusetts Bays Program will begin to identify and support the implementation of administrative, legislative, or regulatory changes, enforcement proceedings, technical solutions (stormwater best management practices, buffer zone experiments, etc.) at the federal, state, and local levels.

In order to be successful, the Massachusetts Bays Program must establish the public consensus that will ensure long-term support of the estuary program, specifically in developing and implementing the CCMP. This effort will involve working with local governments and citizens groups to determine regional/local needs and issues and to design effective strategies for managing embayments. Two ways to develop such strategies include information dissemination and building the technical capacity for pollution abatement at the local and regional levels.

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APPENDIX A. THE MANAGEMENT FRAMEWORK IN MASSACHUSETTS BAYS

The wise management and utilization of the resources in Massachusetts Bays come under the purview of a variety of legislative mandates and regulatory agencies at the federal, state, regional, and local levels. In addition, there are a number of nonregulatory programs carried out by governmental entities, including regional planning agencies, that play a role in restoring and protecting Massachusetts Bays. This appendix provides both an overview of the existing governmental framework and a context for many of the recommendations described in the CCMP Action Plan.

Federal Agencies

US ENVIRONMENTAL PROTECTION AGENCY

The US Environmental Protection Agency (EPA) operates under several important pieces of federal legislation of concern in Massachusetts Bays. These include: the Clean Water Act; the Comprehensive Environmental Response, Compensation, and Liability Act; and the National Environmental Policy Act.

The Clean Water Act of 1977 regulates "discharges" from all point sources into navigable waters of the United States. Its coverage generally extends to pipeline discharges and the disposal of dredged material in estuaries. Outfalls from land-based facilities such as sewage treatment plants and industrial plants also are subject to regulation under the Clean Water Act.

Under the Clean Water Act, as amended by the Water Quality Act of 1987, EPA is responsible for:

- Coordinating the National Estuary Program, of which Massachusetts Bays is one of 17 "estuaries of national significance." EPA Region I has direct responsibility for the administration of the Massachusetts Bays Program.
- Regulating industrial discharges and publicly owned sewage treatment facilities under the National Pollutant Discharge Elimination System, which governs point source pollution.
- Setting water quality standards for all significant bodies of surface waters.
- Controlling nonpoint source pollution, such as agricultural and stormwater runoff.
- Protecting wetlands and other waters by co-administrating, with the US Army Corps of Engineers, a permitting program that regulates the discharge of dredged or fill material into waters of the United States.
- Administering the Construction Grants Program and the State Revolving Loan Funds.

Under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, and the amendment SARA, better known as Superfund, EPA is to provide emergency response and cleanup capabilities for chemical spills and releases from hazardous waste treatment, storage, and disposal facilities.

The National Environmental Policy Act of 1970 requires that an Environment Impact Statement (EIS) be prepared for all proposed legislation and all major federal activities that could significantly affect the quality of the human environment.

US ARMY CORPS OF ENGINEERS

The U.S. Army Corps of Engineers provides engineering services and construction support for a wide variety of military and civilian projects. The Corps' primary civil role is to develop and manage the country's waterways and wetlands. Its projects include reducing flood damage,

improving harbors and navigation channels, protecting stream banks and shorelines, and other activities aimed at preserving and safeguarding the environment.

The Corps issues permits (under Section 404 of the Clean Water Act) for discharging of dredged materials into waters or placing dredged (or fill) material in waters or wetlands. Hence, constructing piers, docks, ramps, or any dredging activities in navigable waters requires 404 permits. As part of its navigational responsibilities, the Corps develops, maintains, and improves harbors and waterways to meet commercial and recreational needs. Operating and maintaining the 17.5-mile-long Cape Cod Canal is under the jurisdiction of the Corps. The Corps of Engineers also helps to protect and restore shores and beaches from erosion damage.

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

The National Oceanic and Atmospheric Administration (NOAA) is part of the Department of Commerce. As the nation's lead marine science agency, NOAA's estuarine and coastal program responsibilities involve research, data collection and assessment, and management. As a part of NOAA, the National Marine Fisheries Service seeks to" achieve a continued optimum utilization of living resources for the benefit of the nation."

NOAA's research programs are directed at improving current knowledge of the physical processes of estuaries, the natural and human-induced factors affecting the productivity and health of fishery resources, and the effects of habitat loss and of chemicals and pathogens on edible fish and shellfish.

NOAA collects, archives, and synthesizes a variety of oceanographic, climatic, fisheries, and pollution data. Its Status and Trends Monitoring Program measures the effects of environmental degradation by toxic chemical in sediments, fish, and shellfish. Under this program, NOAA conducts sampling in Massachusetts Bays.

The Coastal Zone Management Act of 1972, administered by NOAA, provides funds, policy guidance, and technical assistance to coastal states to help them establish and maintain coastal zone management programs. Such programs are designed to promote the wise use and protection of coastal land and water resources. The Massachusetts Coastal Zone Management Program was the first state effort on the East Coast and the fourth in the nation to receive federal approval in 1978.

As required by the Coastal Zone Management Act, the state program reviews all federally conducted or supported activities that directly affect the coastal zone. The purpose of the review is to ensure that these activities are in compliance with approved state environmental programs. This federal consistency review process is a powerful implementation tool to protect and manage the coastal zone in Massachusetts Bays. The Massachusetts Bays Program is administered by the Massachusetts Office of Coastal Zone Management in conjunction with EPA Region I.

USDA SOIL CONSERVATION SERVICE

The Soil Conservation Service (SCS) is part of the US Department of Agriculture (USDA). SCS supports local communities in the areas of agricultural waste management and stormwater runoff management, which are two nonpoint pollution sources in Massachusetts Bays. In the past, SCS focused primarily on agricultural practices. Recently, SCS has redirected its efforts to provide technical assistance to communities experiencing impacts from development.

In addition, USDA is in the process of implementing a new program, the hydrographic unit initiative, in response to Presidential concern for the declining quality of the nation's ground and surface water. Under this initiative, SCS has begun a three-year program to provide education and technical assistance to reduce nonpoint source pollution from agricultural operations and stormwater.

US FISH AND WILDLIFE SERVICE

The US Fish and Wildlife Service has the principal federal responsibility for conserving the nation's fish and wildlife, including their related habitats. The Service operates under a variety of federal conservation statutes in implementing this mission and administers the National Wildlife Refuge System, a national system of fish hatcheries and research centers, and operates several hundred field offices involved in all aspects of wetlands protection, fish and wildlife surveys, contaminants cleanup, and endangered species protection.

Although the Service has no direct regulatory control concerning discharges of pollutants into waters of the United States or discharge of dredged or fill materials, the agency plays a direct advisory role in these regulatory practices. Under the Fish and Wildlife Coordination Act, the Service must assess the impacts on fish and wildlife of all water and water-related development projects that are funded by the federal government or constructed under a federal permit or license. The Service provides information to federal contstruction or regulatory agencies and to permit applicants. Such inovlvement includes analyzing and reporting on construction proposals and applications for dredge and fill permits issued by the COE, ocean dumping permits issued by the EPA, bridge and causeway permits issued by the Coast Guard, license applications submitted to the Federal Energy Regulatory Commission, and any proposed federal construction affecting fish and wildlife resources.

Actions authorized, funded, or carried out by federal agencies require the Service's review under the Endangered Species Act. All such federal projects are to ensure that their activities do not jeopardize the existence of an endangered species or result in the destruction or modification of their critical habitat.

The Service is also a coastal landowner via its acquisition of significant migratory bird habitat (under the Migratory Bird Conservation Act), habitat for endangered species (under the Endangered Species Act), and recreation and wilderness areas (under the Land and Water Conservation Fund Act). All acquisitions become part of the National Wildlife Refuge System.

The Fish and Wildlife Service also exercises other conservation activities pursuant to the Oil Pollution Act; the Comprehensive Emergency Response, Compensation and Liability Act; the Coastal Barrier Resources Act; and the Coastal Wetlands Planning, Conservation and Restoration Act.

US COAST GUARD

The United States Coast Guard enforces provisions of the Clean Water Act regarding discharges of oil, hazardous substances, and sanitary wastes from boats and ships. The Coast Guard also establishes regulations regarding performance standards for marine sanitation devices, in cooperation with EPA. The Coast Guard regulates all public and private aids to navigation used in coastal waters.

US FOOD AND DRUG ADMINISTRATION

The US Food and Drug Administration is responsible for the safety of the nation's foods, including seafood. The FDA has authority to prescribe the level of contaminant that will render a food adulterated by establishing an **action level** (an informal judgment about the level of a food contaminant to which consumers may be safely exposed) or a **tolerance** (a regulation having the force of law).

The FDA also develops methods for detecting, quantifying, and identifying contaminants in shellfish and estuarine waters. The FDA supports the National Shellfish Sanitation Program (NSSP), a cooperative state/federal/industry program for the sanitary control of the shellfish industry. As part of the NSSP, FDA provides technical assistance to states, such as Massachusetts, in studying specific pollution problems, by providing data to establish closure levels for shellfish harvesting,

by conducting applied research in various contaminants to assist in developing standards and criteria, and by evaluating the effectiveness of state shellfish sanitary control programs.

State Agencies

EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS

The Executive Office of Environmental Affairs (EOEA) is a cabinet-level secretariat whose principal authority is to implement and oversee state policies that preserve, protect, and regulate natural resources and the environmental integrity of the Commonwealth of Massachusetts. Of the departments and units within EOEA, the following are most involved with management issues for Massachusetts Bays:

- Massachusetts Coastal Zone Management Office (CZM)
- Massachusetts Environmental Policy Act Unit (MEPA)
- Department of Environmental Protection (DEP)
- Department of Environmental Management (DEM)
- Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE)

The responsibilities and activities of these agencies are described below.

Massachusetts Coastal Zone Management

The Massachusetts Coastal Zone Management Office (CZM) develops state policy to protect resources and manage development in the coastal zone. As officially defined, the Massachusetts Coastal Zone extends landward to 100 feet beyond specified major roads, rail lines or other visible rights-of-way and seaward to the edge of the territorial sea and includes all of Cape Cod, Martha's Vineyard, Nantucket and Gosnold.

Developed under the authority of the federal Coastal Zone Management Act of 1972, the Massachusetts Coastal Zone Management Plan was approved in 1978 and established twenty-seven policies to protect and manage the Commonwealth's coastal zone and its valuable resources.

CZM is a planning and policy agency. To carry out its responsibilities, the agency relies upon existing state regulatory authority and the federal consistency review process. CZM administers a number of local financial assistance grant programs and provides technical assistance to local communities. The primary areas of CZM concern include coastal hazards, marine environmental protection, energy, waterfront development and harbor planning, and recreation. CZM also supports scientific studies, mapping projects, and other activities that add to the knowledge of coastal resources and enhance planning and decision-making in Massachusetts. The Coastal Resources Advisory Board (CRAB) and various Citizens Advisory Committees add an essential citizen perspective to CZM's work.

Through the federal Coastal Zone Management Act, CZM is empowered to review all federal activities in Massachusetts to ensure they are consistent with state coastal policy. Any large coastal project requiring a federal license or permit, implemented by a federal agency, or carried out with federal funds must undergo this CZM consistency review.

The Coastal Facilities Improvement Program is administered by CZM to assist eligible coastal communities in the construction, reconstruction, repair, or maintenance of coastal facilities and the preparation of comprehensive harbor plans.

Massachusetts Environmental Policy Act Unit

The Massachusetts Environmental Policy Act (MEPA) directs state agencies, when permitting and licensing proposed development, to review, evaluate, and determine the impact on the natural

environment of these works, projects, or activities and to use all practicable measures to mitigate their impacts and minimize damage to the environment. Regulations under Title 301 of the Code of Massachusetts Regulations (CMR) Chapter 11.00 define which projects are subject to MEPA review. Projects below thresholds are exempt, although larger projects or projects in sensitive areas are likely to trigger MEPA review.

Department of Environmental Protection

The Department of Environmental Protection (DEP) administers most of the Commonwealth's environmental regulatory programs. These programs address a variety of concerns including air and water quality, solid and hazardous waste disposal, and development of wetlands and waterways. The following discussion describes the divisions most closely related to the CCMP.

Division of Wetlands and Waterways

The Division of Wetlands and Waterways administers three programs—the Coastal Wetlands Restoration Program (Massachusetts General Laws, Chapter 130, Section 105), Wetlands Protection Program (Massachusetts General Laws, Chapter 131, Section 40), and the Waterways Act (Massachusetts General Laws, Chapter 91).

Wetlands Protection—Conservation commissions are the first line of defense in wetlands protection under the Massachusetts Wetlands Protection Act. They have primary authority to review projects proposed in or near wetlands, and issue Orders of Condition (which are written statements that control the impact of activities in wetlands by stating the conditions under which the activities must take place). Regulations and policies to guide the conditioning process are developed by the Division of Wetlands and Waterways. The division reviews local conservation commission decisions which have been appealed. All decisions by DEP may be appealed to an adjudicatory hearing.

Wetlands Restriction—Activities within especially large or otherwise significant wetland areas throughout Massachusetts are controlled by the Inland and Coastal Wetlands Restriction Acts. Restrictions are placed on the deeds of properties within significant wetlands, which gives these resource areas an extra measure of protection. About two thirds of the state's coastal wetlands have been mapped and restricted, and the Division is now working to complete the process throughout the state.

Chapter 91 (Waterways) Licensing—Massachusetts General Law Chapter 91 requires that DEP review and license activity in state waterways. Activities which require Chapter 91 licenses include the placement of piers, wharves, and other structures or fill; changes in use of existing structures and fill; and dredging. Before a Chapter 91 license is issued, Wetlands and Waterways must determine that the proposed project will not interfere with navigation or the operation of public facilities, is structurally sound, promotes public access and will not diminish public rights or the rights of adjacent shoreline property owners, and finally, will not adversely impact environmental resources such as wetlands, fish runs, shellfish beds, and fish spawning and nursery areas.

Division of Water Pollution Control

The Division of Water Pollution Control (DWPC) is the lead unit for improved water quality and water pollution prevention in accordance with the provision of the Massachusetts Clean Water Act. The Division issues Water Quality Certificates—permits that regulate pollution discharges and the effects of dredging projects on water quality. The Division also issues National Pollutant Discharge Elimination System Permits (NPDES) for surface water discharges and separate permits for groundwater discharges. NPDES permits are jointly issued by DEP and EPA, who develop discharge limits to ensure compliance with water quality standards. Groundwater permits are required for discharges greater than 15,000 gallons of sewage and any industrial waste. In addition, the DWPC administers the Massachusetts Nonpoint Source Control Program.

Bureau of Municipal Facility Grants and Loans

The Bureau of Municipal Facility Grants and Loans administers the state/federal construction grants program which has evolved from a previous federal and state combined grant program that once provided state grants for planning, and federal and state grants for the construction of municipal sewage treatment plants. This program is now principally a loan program under a state revolving fund. A construction grants program is also available. This program is directed at wastewater projects that are not funded by the federal program or have lower priority in the federal system.

Division of Hazardous Waste

The Division of Hazardous Waste regulates transportation, storage, and disposal of waste materials within the Commonwealth, and monitors the environmental impact of these materials with regard to public health and safety. The Division licenses haulers of hazardous waste, uses computers to track waste disposal, and penalizes offenders of state and federal hazardous waste regulations. The Division also works to clean up existing hazardous waste sites, and assists communities in cleaning up oil and chemical spills.

Division of Solid Waste Management

The Division of Solid Waste Management regulates solid waste generated by muncipalities, industry, commercial sources, and consumers. The Division assesses waste sites and waste facilities, and enforces all provisions of the Massachusetts Solid Waste Act. The Division also develops and manages programs for recycling, composting, and other technologies for waste minimization and source reduction.

Department of Environmental Management

The Department of Environmental Management (DEM) is responsible for preserving and protecting the natural resources of the Commonwealth and for managing state lands and waters. The work of the following divisions are most closely related to the CCMP.

Division of Water Resources

The Division of Water Resources has three priorities: to collect, refine, and update basic water resources data for dissemination to state, federal, and local agencies and the general public; to prevent loss of life and damage to property through flood control; and to facilitate the development of a comprehensive water resources management plan for Massachusetts.

The Division acts as state coordinator for the National Flood Insurance Program administered by the Federal Emergency Management Agency (FEMA).

The State's Ocean Sanctuaries Program is located in this Division. The Ocean Sanctuaries Act (Massachusetts General Laws Chapter 132A, Section 13-16 and 18) established sanctuary areas that must receive a special level of protection from "...any exploitation, development, or activity that would seriously alter...endanger the ecology or the appearance of the ocean, the seabed, or subsoil.

Division of Waterways

The Division of Waterways improves, develops, maintains, and protects the Commonwealth's inland and coastal waterways. Specific programs include the Rivers and Harbors Program, which identifies the need for renovations and improvement to the state's inland and coastal waterways; waterways projects, which include dredging to maintain navigable channels, beach nourishment, and the construction and rehabilitation of piers and other coastal facilities; the State Piers in Gloucester, New Bedford, and Fall River, which are administered by the Division and leased to private operators and managers; recreational facilities projects, including capital improvements

to existing state recreational facilities (beaches, etc) and construction of new ones; and public access projects, including the design and construction of marinas, boat ramps, and Public Access Board projects funded by the Department of Fisheries, Wildlife and Environmental Law Enforcement, but administered by the Division of Waterways as the contracting agent.

Office of Technical Assistance

The Office of Technical Assistance (formerly Safe Waste Management) is responsible for planning and facilitating the safe and efficient management of hazardous waste in Massachusetts. The Office of Technical Assistance sponsors the Household Hazardous Waste Program, which funds community collections of household hazardous waste, and works to increase public awareness of the larger problem of hazardous waste disposal statewide. They have also conducted pilot projects on source reduction in industrial discharges. This program employed audit teams — a free multimedia, nonregulatory service provided to businesses with industrial discharges.

Department of Fisheries, Wildlife and Environmental Law Enforcement

The Department of Fisheries, Wildlife, and Environmental Law Enforcement (DFWELE) is responsible for the management and conservation of the Commonwealth's fresh and saltwater fisheries and its wildlife, including rare and endangered species. The Department enforces the state's wildlife laws and regulations, and conducts research on wildlife and the environmental factors that influence them. The Department also has jurisdiction over registration and operation of motorboats and off-road vehicles, and operates 140 public access sites statewide.

Division of Marine Fisheries

The Division of Marine Fisheries protects and enhances the state's living marine resources, especially commercially and recreationally caught shellfish, lobster, and finfish. As part of its management responsibilities, the Division issues permits for the taking, harvesting, and landing of fish for commercial purposes as well as permits for the recreational harvest of lobsters. A unique feature of the Massachusetts fisheries laws provides local control of shellfish, eels, sea worms, and alewives.

The Division administers the Shellfish Sanitation Program and determines the classification of shellfish areas within the state. It also works to promote and develop Massachusetts' commercial and recreational fisheries and to implement strategies that will maintain the integrity and future availability of the Commonwealth's valuable marine resources.

Department of Public Health

The Massachusetts Department of Public Health, which is housed within the Executive Office of Human Services, is the state agency responsible for disease prevention. This administrative mandate encompasses a broad spectrum of public health issues relating to environmental health, communicable disease control, community health, health care quality, and health education. The divisions within the Department whose activities most closely relate to the goals and objectives of the CCMP are highlighted below.

Division of Communicable Disease Control

The Division of Communicable Disease Control conducts epidemiological investigations of foodborne illnesses to determine their source, and implements disease prevention strategies to minimize further transmission of disease.

Division of Food and Drugs

The Division of Food and Drugs is the regulatory branch of the Department. The Division enforces state and federal regulations regarding the wholesomeness of food products, performs inspections of food establishments for compliance with hygienic standards, and conducts field investigations of foodborne illnesses.

State Laboratory Institute

The State Laboratory Institute analyzes fish, shellfish, and biological fluids for bacterial contamination and marine biotoxins. The laboratory data are useful for determining the cause of an acute foodborne illness and for ensuring compliance with existing regulatory limits. In the past, the laboratory also tested food, environmental, and biological samples for a variety of chemical contaminants of chronic health concern.

Division of Environmental Epidemiology and Toxicology

The Division of Environmental Epidemiology and Toxicology evaluates the risk of exposure to chemical contaminants by performing quantitative risk assessments, health assessments, and epidemiological studies. The Division may recommend a variety of exposure reduction strategies including regulatory action and public health advisories.

Regional Planning Agencies

Regional planning in Massachusetts is carried out by 13 active regional agencies (RPAs) formed under Chapter 40B of Massachusetts General Laws. The RPAs represent the participating cities and towns in each region and employ professional staff that carry out planning activities. The RPAs compile data, conduct research, and prepare comprehensive plans for the area's physical, social, and economic development.

One of the responsibilities of the RPAs is to participate with the Executive Office of Communities and Development in the review of federal funding applications and federal development proposals. This review is the so-called "A-95" review and gets its name from the U.S. Office of Management and Budget circular A-95 which was established in 1969 to provide for the review of almost 1,000 federal programs. In 1982 this was modified to allow states and RPAs to develop their own process and reduce the number of programs to be reviewed to approximately 200. This process is known as the Intergovernmental Review Process.

Four RPAs represent the 48 communities of the Massachusetts Bays area. These are Merrimack Valley Planning Commission (MVPC), Metropolitan Area Planning Council (MAPC), Old Colony Planning Council, and Cape Cod Commission (CCC). Planning staff from each of these RPAs provide a broad range of technical assistance to their respective communities and produce regional plans in the areas of environmental protection, housing, and transportation.

A significant new focus on regional planning may be on the horizon for Massachusetts. Beginning in 1986, the then Cape Cod Planning and Economic Development Commission (CCPEDC), predecessor to the Cape Cod Commission, embarked on an innovative approach to planning for the future of Cape Cod. Through a process of consensus-building, citizens of the Cape identified a need to have more effective land use planning, and have greater authority to regulate land use, control urbanization, and better manage shared resources. The result was a proposal to create a Cape Cod Commission with certain regulatory and regional powers. In November 1988, 76% of Cape Cod voters supported a non-binding referendum to establish the Cape Cod Commission. In January 1990, state legislation was passed to create the Cape Cod Commission. This legislation was ratified by the voters of Cape Cod in a special countywide election on March 27, 1990.

Local Agencies

The Commonwealth of Massachusetts has a long-standing tradition of local self-determination or home rule. But it was not until 1966, with the adoption of the Home Rule Amendment to the state's constitution, that this philosophy changed the thinking and actions of legislation and court decisions in Massachusetts. Generally, municipalities are authorized to exercise through the "adoption, amendment, or repeal of local ordinances or by-laws...any power or function...not denied" by the State. This is one of the strongest declarations in this country of the right to local control. The legislature, while it has the authority, has rarely used its power to preempt local initiative.

Home rule authority is highly valued and strongly defended in Massachusetts communities. Land use controls, in particular, are viewed as a local prerogative. In the Massachusetts Bays region, attention to land use issues is of vital importance to environmental quality and conservation of resources. However, towns and cities must follow ground rules for local governments as stipulated in state law. Legal decisions that strike down local controls are most likely to be based on procedural problems than on the substance of what the community is attempting to accomplish.

BOARDS OF HEALTH

Towns elect a Board of Health (most have three members), or the selectmen can act in this capacity. A Board of Health has far-reaching authority in exercising its responsibility to protect the health, safety and welfare of the community. Their broad regulatory authority has thrust them into the forefront of environmental protection on the local level. Boards of health can adopt regulations for any activity that might endanger public health or contaminate surface or groundwater. In many communities, the chief duties of boards of health have become the regulation of landfills and approval of septic system installations. Under Title 5 (State Sanitary Code), health boards issue permits for any septic system receiving up to 15,000 gallons per day (e.g., a large condominium project); larger systems must be approved by DEP. In granting or denying a permit, the Board relies primarily on two tests: a percolation test to see if the soil will pass liquid through at a reasonable rate and a deep-hole test to determine the level of groundwater.

Boards of health have a major role in subdivision review. They have special authority over drainage and waste disposal in proposed subdivisions. Every definitive subdivision plan must be submitted to the board for its recommendations to the planning board. If the board of health rejects a plan, providing specific reasons why areas are not suited for building, the planning board cannot override the decision. However, there must be evidence that a serious pollution problem is likely to occur if the development goes forward.

CONSERVATION COMMISSIONS

The Conservation Commission Act of 1957 enabled local towns to establish a special commission to protect natural resources, serve as an advisor in municipal decision-making, accept gifts of money and land, and regulate local wetland use. When the DEP developed its regulations for the Wetlands Protection Act in 1978 and 1983, most municipalities found it necessary to establish a Conservation Commission to administer new and relatively stringent state wetland regulations. Commissions consist of three to seven members appointed by the selectmen.

Conservation Commissions determine if a proposed project will alter wetland resources and what conditions are required to protect the statutory wetland interests of water supplies, prevention of storm drainage, prevention of pollution, and protection of fisheries and wildlife habitat. Commissions have the authority to order modifications of a proposed project if they determine that it will damage or destroy a wetland resource. Conservation Commissions have authority to regulate within 100 feet of inland and coastal wetland and areas within 100 feet of inland and coastal wetlands within the 100-year floodplain, and within land under water bodies and waterways.

Home rule allows the municipalities to expand state regulations by adopting local wetland bylaws. These bylaws may give conservation commissions the authority to adopt regulations, tighten permit requirements, and add wetland values to be protected. Conservation commissions also have the authority to accept and hold permanent or temporary conservation restrictions. These restrictions authorize and enable the Commission to prevent landowners from using their land in a way that damages natural resources. Conservation commissions can also acquire conservation lands that are valuable for habitat protection, aquifer protection, open space, or any environmental value.

HARBOR MASTERS

Harbor masters have broad powers to regulate uses and activities of waterways. The harbor master is typically appointed by the selectmen to oversee harbor activities and enforce Massachusetts General Laws Chapter 90B Section 15B. These regulations authorize towns, through their harbor masters, to regulate vessels in municipal waterways. The regulations address the safe operation of boats, boat speed limits, channel obstructions, boat seaworthiness, fishing, swimming, diving, and refueling. Some municipalities have harbor regulations that limit the number of moorings to avoid crowding and boat pollution in certain areas. Harbor regulations may also prohibit the discharge of trash, oil, and untreated sewage into town waters.

PLANNING BOARDS

Planning Boards are authorized by Massachusetts General Laws Chapter 41 (containing the municipal planning and subdivision control acts) to plan for the "resources, possibilities, and needs" of their communities, including the protection of natural resources. Planning Boards contain from five to nine members. Towns have the option of deciding by town meeting vote whether the Board shall be appointed by the selectmen or elected by the voters.

Planning Boards are generally responsible for community development through the adoption and implementation of zoning and subdivision ordinances or bylaws. Zoning is one of the basic powers conferred on local government under home rule. Zoning in Massachusetts is employed to guide the physical development of a community by dividing the municipality into zones and specifying the permissible land use, for example, residential, commercial, industrial.

Subdivision regulations govern the process of dividing a parcel of land into two or more lots. Under these regulations, Planning Boards generally require each developer to submit a subdivision plan for approval prior to the start of any construction. Approval or nonapproval is based on compliance of the proposed development with standards as provided in the local subdivision regulations.

ZONING BOARDS OF APPEALS

Boards of Appeals were established by Massachusetts General Laws Chapter 40A to authorize zoning variances to alleviate individual hardship from subdivision control and zoning by-laws or ordinances. In addition, decisions may also be appealed to the Superior Court. The mayor (subject to confirmation of the city council) or Board of Selectmen appoint the three or five-member Zoning Board of Appeals. Under the law, no variances can be granted unless three circumstances existing on a property create a hardship for the owner and entitle that owner to a variance: soil conditions, shape of lot, and topography. The other major duty assigned to boards of appeals is to hear and decide applications for special permits. Often this involves permits in special zoning areas, such as an overlay protection district. The boards of appeals also are empowered to issue comprehensive permits under the affordable housing provisions of Chapter 40B.

APPENDIX B. EOEA LONG-RANGE HABITAT RESEARCH AND MONITORING AGENDA

Coastal Habitats

1. Re-examine the marine living resources of some of the estuaries that were surveyed by the Division of Marine Fisheries in the 1960's and early 1970's as part of their estuarine studies program.

Accelerated growth and development in the coastal zone over the past 20 years have caused concern over potential long-term effects of habitat alteration and pollution on estuarine resources. In order to learn how these alterations have affected the resources within the estuaries, and to better understand the structure and function of estuarine ecosystems, representative estuaries should be intensively surveyed and re-assessed. The estuaries surveyed 20 years ago by MDMF can provide a basis for comparison with current conditions.

The goals of the estuarine studies would be to:

- Evaluate the current health, historical changes, and nursery value of salt marshes and eelgrass beds, so that these areas can be better managed and, if necessary, restored.
- Determine the status of and threats to the shellfish resources within each estuary so that remedial actions can be proposed and implemented.
- Compare the present species composition, abundance, and diversity of inshore fish and invertebrates with that found in the past.

The information from these studies will be essential to formulating future management decisions, regulations, and restoration plans. The proposed studies will focus on fewer estuaries but be broader in scope than the earlier MDMF studies, in which 17 estuaries were surveyed. As in the earlier studies, the proposed surveys should include comprehensive biological, chemical, and physical information. The new studies should include an expanded survey of the estuary as a habitat that supports the propagation of commercially-important resources, but should also include a comprehensive assessment of the structure and health of the ecosystem, pinpoint specific threats to the living resources, and evaluate how the estuary has changed since the past MDMF survey.

Three estuaries that were examined by MDMF previously should be re-examined in this evaluation. The three would be chosen to represent an urban harbor, a moderately impacted area, and an area that was relatively pristine when the original MDMF survey was done. Although suggestions are made for each cateogry, the final selection of estuaries to be surveyed might be based to some extent on available funding.

- Urban Harbor

  Dorchester Bay, Quincy Bay, or Hingham Bay

  Beverly/Salem

  Lynn/Saugus
- Moderately Impacted Harbor

  Gloucester/Annisquam

  Plymouth/Kingston/Duxbury

  Marshfield/North River
- Relatively Undeveloped Harbor

  Wellfleet Bay

2. Study the use of indices of appropriate buffer distances that will protect water quality and wildlife habitat functions of coastal wetlands.

The present 100-foot buffer distance in the Massachusetts Wetlands Protection Regulations may be inadequate for protecting these wetland functions. Buffer distances should be designed using site-specific information.

3. Evaluate the cumulative impacts of projects adjacent to coastal wetlands.

Coastal vegetated habitats can be degraded as easily by the cumulative effects of many small projects (houses, piers, etc.) as by one large project. Such small projects often fall through the regulatory net, because they are too small individually to have a significant effect on coastal habitats. The impact of gradual, but cumulative, encroachment on coastal habitats should be reviewed and, if necessary, controlled. Creative zoning approaches, such as the nutrient loading bylaws of Falmouth, should be employed to deal with cumulative impacts.

4. Evaluate the potential for restoring salt marshes and eelgrass beds that have been degraded by past human activity.

As part of this evaluation, the Technical Advisory Group suggests examining the potential of adapting Open Marsh Water Management mosquito control procedures to restore degraded salt marshes. Mitigation for current development should be avoided unless research demonstrates that artificial wetlands adequately replace all the functions of natural ones.

Shellfish

1. Identify clam flats within impacted estuaries for cleanup.

Clam flats would be prioritized statewide based on the extent and type of pollutants, the value of the resource, and the cost of restoration. Much of the data needed for this prioritization is currently being collected by MDMF. Determining the sources of bacterial and, when relevant, ancillary pollutants (PCBs, hydrocarbons, metals, etc.) may be required in certain locales. Cost-benefit analysis is currently the major data gap that must be filled.

2. Establish a statewide toxics monitoring program using the sentinel sessile bivalve, *Mytilus edulis*, in representative estuaries.

This program should be compatible with NOAA's National Status and Trends Program and be integrated with the upcoming Gulf of Maine Monitoring Program. It will be valuable for detecting long-term trends in water quality throughout the Commonwealth. This program should be initiated as part of the estuarine studies recommended above.

Finfisheries

1. Assess the impact of loss of estuarine nursery habitats as they relate to coastal fishery resources.

2. Evaluate the relative impact of fishing, contaminants, and estuarine habitat degradation on marine fisheries.

This complex issue ultimately needs to draw on several data sources, such as the semi-annual MDMF stock assessment and site-specific estuarine surveys described previously. Understanding the relative impact of each will contribute to the development of appropriate management strategies for an inshore fisheries management plan, as recommended by the Marine Resources Coordinating Committee.

APPENDIX C. ACRONYMS

A

ACEC	Area of Critical Environmental Concern
ACP	Area Contingency Plan
ASP	Amnesic Shellfish Poisoning

C

CAC	Citizens Advisory Committee of the MBP
CA/T	Central Artery/Third Harbor Tunnel Project
CCC	Cape Cod Commission
CCMP	Comprehensive Conservation and Management Plan
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
cfs	cubic feet per second
COE	Army Corps of Engineers
CSO	Combined Sewer Overflow
CZM	Coastal Zone Management Office

D

DEM	Department of Environmental Management
DEP	Department of Environmental Protection
DFWELE	Department of Fisheries, Wildlife and Environmental Law Enforcement
DMF	Division of Marine Fisheries
DPA	Designated Port Area
DPH	Department of Public Health
DSP	Diarrhetic Shellfish Poisoning
DWPC	Division of Water Pollution Control

E

EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EOEA	Executive Office of Environmental Affairs
EPA	Environmental Protection Agency

F

FDA	Food and Drug Administration

M

MAPC	Metropolitan Area Planning Council
MassGIS	Massachusetts Geographic Information System
MBDS	Massachusetts Bay Disposal Site
MBP	Massachusetts Bays Program

MDC	Metropolitan District Commission
MEPA	Massachusetts Environmental Policy Act
MESA	Massachusetts Endangered Species Act
mgd	million gallons per day
MSD	Marine Sanitation Device
MVPC	Merrimack Valley Planning Commission
MWRA	Massachusetts Water Resources Authority
N	
NAS	National Academy of Sciences
NETSU	Northeast Technical Services Unit
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NSSP	National Shellfish Sanitation Program
NWR	National Wildlife Refuge
O	
OCPC	Old Colony Planning Council
ODES	Ocean Data Evaluation System
ODMDS	Ocean Dredged Material Disposal Site
OWOW	Office of Wetlands, Oceans and Waterways (EPA)
P	
PAC	Port Area Committee
PAH	Polycyclic Aromated Hydrocarbons
PCB	Polychlorinated Biphenyls
PSP	Paralytic Shellfish Poisoning
R	
RDOA	Request for Determination of Applicability
RPA	Regional Planning Agency
S	
SCS	Soil Conservation Service
SESD	South Essex Sewage District
T	
TAC	Technical Advisory Committee of the MBP
U	
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
W	
WPA	Wetlands Protection Act

APPENDIX D. GLOSSARY

Action Plan. A compilation of agreed-upon goals and objectives and a list of specific strategies or actions indicating who, what, where, and when the objectives will be achieved.

Aerobic. Living, active, or occurring only in the presence of oxygen.

Algae. Aquatic, non-flowering plants that lack roots and use light energy to convert carbon dioxide and inorganic nutrients such as nitrogen and phosphorus into organic matter by photosynthesis. Common algae include dinoflagellates, diatoms, seaweeds, and kelp.

Algal Bloom. A condition resulting from excessive nutrient levels or other physical and chemical conditions that enable algae to reproduce rapidly.

Amnesic Shellfish Poisoning (ASP). An illness associated with the consumption of shellfish contaminated with domoic acid (an amino acid produced by a diatom). Symptoms of ASP usually develop within 24 hours of eating contaminated shellfish. The acute illness is characterized by gastrointestinal symptoms of vomiting, abdominal cramp, and diarrhea. Within 48 hours, neurological symptoms such as confusion, disorientation, or memory loss may develop. There may be chronic effects associates with ASP which include permanent loss of short-term memory and central nervous system dysfunction.

Anadromous Fish. A species, such as salmon, alewives, or river herring, that is born in fresh water, spends a large part of its life in the sea, and returns to freshwater rivers and streams to reproduce.

Anaerobic. A process occurring in the absence of free oxygen.

Anoxic. A condition in which oxygen is absent.

Antidegradation provision. Standards in the Clean Water Act which regulate activities in order to maintain and protect existing water uses in designated areas.

Aquaculture. The controlled cultivation and harvest of aquatic plants or animals (e.g., edible marine algae, clams, oysters, and salmon).

Area of Critical Environmental Concern (ACEC). An area encompassing land and water resources of regional, statewide, or national importance, designated by the Secretary of the Executive Office of Environmental Affairs (in accordance with 301 CMR[1] 12:6.40-6.55), to receive additional protection and management.

Aromatic Hydrocarbons. Compounds that contain at least one 6-carbon ring; often important components of oils.

Attenuation. The process by which a compound is reduced in concentration over time or distance through absorption, degradation, or transformation.

Barrier Beach. A narrow, low-lying strip of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. It is separated from the mainland by a narrow body of fresh, brackish, or saline water or by a marsh system.

Beneficial Uses. Uses designated in Massachusetts Surface Water Quality Standards — for public water supply, for protection and propagation of fish and other wildlife, and for primary and secondary contact recreation — and any other uses that do not impair these designated uses.

[1] CMR=Commonwealth of Massachusetts Regulation

Best Management Practice (BMP). A method for preventing or reducing the pollution resulting from an activity. The term originated from rules and regulations in Section 208 of the Clean Water Act. Specific BMPs are defined for each pollution source.

Bioaccumulation. The process by which a contaminant accumulates in the tissues of an individual organism. For example, certain chemicals in food eaten by a fish tend to accumulate in its liver and other tissues.

Biochemical Oxygen Demand (BOD). The quantity of oxygen-demanding materials present in a sample as measured by a specific test. A major objective of conventional wastewater treatment is to reduce the biochemical oxygen demand so that the oxygen content of the water body will not be significantly reduced. Although BOD is not a specific compound, it is defined as a conventional pollutant under the federal Clean Water Act.

Board of Health. A municipal, elected or appointed, authority responsible for administering bylaws addressing health, safety, and welfare issues covered in the State Environmental Code, including Title 5.

Bordering Vegetated Wetlands (BVW). As defined in 310 CMR 10.55, the Wetlands Protection Act Regulation, freshwater wetlands that border on creeks, rivers, streams, ponds, and lakes. The types of freshwater wetlands are wet meadows, marshes, swamps, and bogs. They are areas where the topography is low and flat, and where the soils are saturated at least part of the year.

Buildout Analysis. A parcel-by-parcel analysis to estimate the total number of existing and developable units, based on current zoning and other land-use regulations. Such an analysis is essential for managing and limiting impacts of growth.

Carcinogen. A substance that causes cancer.

Carrying Capacity. The limit of a natural or man-made system to absorb perturbations, inputs, or population growth.

Cesspool. A covered pit with a perforated lining in the bottom into which raw sewage is discharged: the liquid portion of the sewage is disposed of by seeping or leaching into the surrounding porous soil; the solids, or sludge, are retained in the pit to undergo partial decomposition before occasional or intermittent removal. Cesspools are no longer permitted for waste disposal.

Chlorinated Hydrocarbons (CHCs). All aromatic and nonaromatic hydrocarbons containing chlorine atoms. Includes certain pesticides, polychlorinated biphenyls, and other solvents.

Coastal Bank. As defined in 310 CMR 10.30(2), the Wetlands Protection Act Regulation, the seaward face or side of any elevated landform, other than a costal dune, which lies at the landward edge of a coastal beach, land subject to tidal action, or other wetland. A typical working definition is "the first major break in slope above the 100-year flood elevation," but this definition may not apply in certain special circumstances.

Coastal Wetland. As defined in Massachusetts General Law Chapter 131, Section 40, the Wetlands Protection Act Regulation, any bank, marsh, swamp, meadow, flat, or other low land subject to tidal action or coastal storm flowage and such contiguous land as the Commissioner of the Department of Environmental Protection deems necessary.

Coastal Zone. As officially defined in 301 CMR 20.00, the zone that extends landward to 100 feet beyond specified major roads, rail lines, or other visible rights-of-way; includes all of Cape Cod, Martha's Vineyard, Nantucket, and Gosnold; and extends seaward to the edge of the state territorial sea.

Coastal Zone Management (CZM) Program. A federally-funded and approved state program under the Federal Coastal Zone Management Act of 1972. The program reviews federal permitting,

licensing, funding, and development activities in the coastal zone for consistency with state policies.

Combined Sewer Overflow (CSO). Any intermittent overflow, bypass, or other discharge from a municipal combined sewer system which results from a flow in excess of the dry weather carrying capacity of the system.

Combined Sewer System. A sewer system which, by design, collects and conveys both wastewater and storm water runoff.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). A federal law administered by the Environmental Protection Agency, dealing with the assessment and remediation of hazardous material disposal sites. Superfund activities are performed under this Act.

Conservation Commission. An appointed municipal agency responsible for administering the Wetlands Protection Act at the local level.

Contaminant. A substance that is not naturally present in the environment or is present in unnatural concentrations that can, in sufficient concentration, adversely alter an environment. Federal regulations (40 CFR 230) for the discharge of dredged or fill material into navigable waters regulated by Section 404 of the federal Clean Water Act define a contaminant as a chemical or biological substance in a form that can be incorporated into, onto, or be ingested by and that harms aquatic organisms, consumers of aquatic organisms, or users of the aquatic environment.

Cumulative Effects. The combined environmental impacts that accrue over time and space from a series of similar or related individual actions, contaminants, or projects. Although each action may seem to have a negligible impact, the combined effect can be serious.

Department of Environmental Management (DEM). The state agency responsible for managing natural resources, including, but not limited to, water resources. DEM administers the Massachusetts Ocean Sanctuaries Act.

Department of Environmental Protection (DEP). The state agency, formerly known as the Department of Environmental Quality Engineering, responsible for administering laws and regulations protecting air quality, water supply, and water resources, such as Chapter 91 and Title 5, and for administering programs such as the Wetlands Protection Program and Wetlands Restriction Program. It is also responsible for overseeing the cleanup of hazardous waste sites and responding to hazardous waste emergencies and accidents.

Department of Public Health (DPH). The state agency responsible for disease prevention. Its administrative mandate encompasses a broad spectrum of public health issues relating to environmental health, communicable disease control, community health, health care quality, and health education. The State Laboratory Institute within the Department analyzes fish, shellfish, and biological fluids for bacterial contamination and marine biotoxins. The laboratory data are useful for determining the cause of an acute foodborne illness and for ensuring compliance with existing regulatory limits.

Designated Port Areas. As defined in Chapter 91 Regulation, that portion of certain urban harbors where maritime-dependent industrial uses are encouraged to locate. This concentration of uses maximizes public investments in dredging, bulkheads, piers, and other port facilities.

Diarrhetic Shellfish Poisoning (DSP). An illness caused by eating shellfish contaminated with okadoic acid (which is produced by several species of dinoflagellates of the genus *Dinophysis*). The symptoms of DSP are diarrhea, nausea, vomiting, abdominal cramp, and chills.

Dissolved Oxygen. Oxygen that is present (dissolved) in water and therefore available for fish and other aquatic animals to use. If the amount of dissolved oxygen in the water is too low, then aquatic animals may die. Wastewater and naturally-occurring organic matter contain oxygen-demanding substances that consume dissolved oxygen.

Division of Marine Fisheries (DMF). The agency within the Massachusetts Executive Office of Environmental Affairs responsible for managing the Shellfish Sanitation Program, overseeing shellfish relays, depuration plants, commercial fishing licenses, and management and stock assessment of Massachusetts fisheries.

Drainage Basin. The land that surrounds a body of water and contributes fresh water, either from streams, groundwater,or surface runoff, to that body of water.

Dredging. Any physical digging into the bottom sediment of a water body. Dredging can be done with mechanical or hydraulic machines, and it changes the shape and form of the bottom. Dredging is done in parts of Massachusetts Bays in order to maintain navigation channels that would otherwise fill with sediment and block ship passage.

Ecosystem. A community of living organisms interacting with one another and with their physical environment, such as a salt marsh, an embayment, or an estuary. A system such as Massachusetts Bays is considered a sum of these interconnected ecosystems.

Eelgrass (*Zostera marina*). A marine flowering plant that grows subtidally in sand and mud. Eelgrass beds are an important habitat and nursery for fish, shellfish, and waterfowl.

Effluent. The outflow of water, with our without pollutants, usually from a pipe.

Embayments. A small bay or any small semi-enclosed coastal waterbody whose opening to a larger body of water is restricted.

Enterococcus. A group of bacteria found in the feces of warm-blooded animals indicative of the presence of sewage.

Environmental Protection Agency (EPA). The federal agency principally responsible for administering the Clean Water Act, National Estuary Program, CERCLA, Superfund, and other major federal environmental programs.

Estuary. A semi-enclosed coastal body of water having a free connection with the open sea and within which seawater is measurably diluted with fresh water.

Eutrophication. The process of nutrient enrichment in aquatic ecosystems. In marine systems, eutrophication results principally from nitrogen inputs from human activities such as sewage disposal and fertilizer use. The addition of nitrogen to coastal waters stimulates algal blooms and growth of bacteria, and can cause broad shifts in ecological communities present and contribute to anoxic events and fish kills. In freshwater systems and in parts of estuaries below 5 parts per trillion salinity, phosphorus is likely to be the limiting nutrient and the cause of eutrophic effects.

Executive Office of Environmental Affairs (EOEA). A cabinet-level secretariat whose principal authority is to implement and oversee state policies that preserve, protect, and regulate natural resources and the environmental integrity of the Commonwealth of Massachusetts. (For more information, see Appendix A.)

Fecal Coliform Bacteria. Fecal coliform bacteria are those coliform bacteria that are found in the intestinal tracts of mammals. The presence of high numbers of fecal coliform bacteria in a

water body can indicate the recent release of untreated wastewater and/or the presence of animal feces. These organisms may also indicate the presence of pathogens that are harmful to humans. High numbers of fecal coliform bacteria therefore limit beneficial uses such as swimming and shellfish harvesting.

Floodplain. The area of shorelands extending inland from the normal yearly maximum stormwater level to the highest expected stormwater level in a given period of time (e.g., 5, 50, 100 years).

Flushing Time. The mean length of time for a pollutant entering a water body to be removed by natural forces such as tides and currents; also referred to as residence time or turnover time.

Food and Drug Administration (FDA). The federal agency that is responsible for, among other things, administering the National Shellfish Sanitation Program.

General Bylaws. Local laws that can be adopted with a simple majority vote at the town meetings. Cities adopt ordinances by a simple majority vote of the city council.

Goal. A general statement describing what is to be achieved in the future. Goals reflect a consensual vision for a specific or general resource.

Grandfathering. A provision from Massachusetts General Law Chapter 40 that allows existing land uses or structures to remain without coming into compliance with upgraded zoning or building requirements.

Habitat. The specific area or environment in which a particular type of plant or animal lives. An organism's habitat must provide all of the basic requirements for life and should be free of harmful contaminants. Typical Massachusetts Bays habitats include beaches, marshes, rocky shores, the bottom sediments, intertidal mudflats, and the water itself.

Holding Tank. An enclosed container used as part of a sewage disposal system on a boat. The tank is used to temporarily store sewage for later pumpout at a marina pumpout facility.

Hypoxia. A condition in which oxygen is deficient.

Impervious Material. With respect to Title 5 regulations, a material or soil having a percolation rate greater than 30 minutes per inch; including, but not limited to, bedrock, peat, loam, and organic matter.

Impervious Surface. A surface that cannot be easily penetrated. For instance, rain does not readily penetrate asphalt or concrete pavement.

Industrial Pretreatment. The removal or reduction of certain contaminants from industrial wastewater before it is discharged into a municipal sewer system. Reduced loading of contaminants from industries can reduce the expense of managing and designing municipal treatment facilities.

Infiltration. The penetration of water through the ground surface into subsurface soil. Some contaminants are removed by this process.

Leaching Facility. An approved structure used for the dispersion of septic-tank effluent into the soil. These include leaching pits, galleries, chambers, trenches, and fields as described in 310 CMR 15.11 through 15.15.

Loading. The total amount of material entering a system from all sources.

Marine Sanitation Device (MSD). A device installed on a boat to treat or hold sewage. Section 312 of the federal Clean Water Act requires all vessels with installed toilets to have approved MSDs. Federal regulations describe three types of MSDs: Type I and Type II MSDs are treatment devices, while Type III MSDs are holding tanks.

Massachusetts Environmental Policy Act (MEPA). Massachusetts General Laws Chapter 30, the state law, administered by the MEPA unit within the Executive Office of Environmental Affairs, establishing a uniform system of environmental impact review.

Massachusetts General Law Chapter 40. The state zoning law for which the municipal planning boards and the zoning boards of appeal are responsible.

Massachusetts General Law Chapter 41. The state law governing subdivisions, administered by municipal planning boards and zoning boards of appeal.

Massachusetts General Law Chapter 91. The Waterways Licensing Program governing waterfront development in Massachusetts, administered by the Department of Environmental Protection and the Office of Coastal Zone Management.

Massachusetts General Law Chapter 111. State law (Section 40) that vests municipal boards of health with the broad authority for maintaining the health, safety, and welfare of the public. Regulations are promulgated under this act through 310 CMR 10.0.

Massachusetts General Law Chapter 131, Section 40. The Wetlands Protection Act (WPA) administered by conservation commissions on the municipal level and by the Department of Environmental Protection on the state level.

Massachusetts Ocean Sanctuaries Act. Administered by the Department of Environmental Management, the state law governing activities and structures in the ocean, seabed, or subsoil that would have an adverse affect on the "ecology or appearance" of the ocean sanctuary.

Mean High Water. The average height of the high tides over a 19-year period.

Mean Low Water. The average height of the low tides over a 19-year period.

Metals. Elements found in rocks and minerals that are naturally released to the environment by erosion, as well as generated by human activities. Certain metals (such as mercury, lead, zinc, and cadmium) are of environmental concern because they are released to the environment in excessive amounts by human activity. They are generally toxic to life at certain concentrations. Since metals are elements, they do not break down in the environment over time and can be incorporated into plant and animal tissue.

National Estuary Program (NEP). A state grant program within the U.S. Environmental Protection Agency established to designate estuaries of national significance and to incorporate scientific research into planning activities.

National Pollutant Discharge Elimination System (NPDES). A requirement in the federal Clean Water Act for dischargers to obtain permits. EPA is responsible for administering this program in Massachusetts.

Neotropical Migrants. Birds that breed in North America and winter in Central and South America. These birds generally migrate through the Massachusetts Bays region.

Nonpoint Source Pollution. Pollution that is generated over a relatively wide area and dispersed rather than discharged from a pipe. Common forms of nonpoint source pollution include stormwater runoff, failed septic systems, and marinas.

Notice of Intent. A form submitted to the municipal conservation commission and DEP which serves as the application for an Order of Conditions under the Wetlands Protection Act. It includes information on the site's wetland resources and the proposed work.

Nutrients. Essential chemicals needed by plants and animals for growth. Excessive amounts of nutrients, nitrogen, and phosphorus, for example, can lead to degradation of water quality and growth of excessive amounts of algae. Some nutrients can be toxic at high concentrations.

Objective. A short term target that, as achieved, incrementally attain goals.

Order of Conditions. The document, issued by a conservation commission, containing conditions that regulate or prohibit an activity proposed in the resource area defined in MGL Chapter 131 Section 40.

Paralytic Shellfish Poisoning (PSP). An illness, sometimes fatal to humans and other mammals, caused by a neurotoxin produced by a type of plankton called *Alexandrium*. During certain times of the year and at certain locations, these organisms proliferate in "blooms" (sometimes called red tides) and can be concentrated by clams, mussels, and other bivalves. The nervous system of shellfish is unaffected. Consumption of the shellfish can cause acute illness in humans and other mammals.

Pathogen. An agent such as a virus, bacterium, or fungus that can cause diseases in humans. Pathogens can be present in municipal, industrial, and nonpoint source discharges into Massachusetts Bays.

Performance Standards. Federal, state, or local codified specification that condition development activities to limit the extent to which a structure or activity may affect the immediate environment.

Petroleum Hydrocarbons. The mixture of hydrocarbons normally found in petroleum; includes hundreds of chemical compounds.

Point Source Pollution. Pollution originating at a particular place, such as a sewage treatment plant, outfall, or other discharge pipe.

Polychlorinated Biphenyls (PCBs). A class of chlorinated aromatic compounds composed of two fused benzene rings and two or more chlorine atoms; used in heat exchange, insulating fluids, and other applications. There are 209 different PCBs.

Polycyclic or **Polynuclear Aromatic Hydrocarbons (PAHs).** A class of complex organic compounds, some of which are persistent and cancer-causing. These compounds are formed from the combustion of organic material and are ubiquitous in the environment. PAHs are commonly formed by the combustion of gasoline and other petroleum products. They often reach the environment through atmospheric fallout and highway runoff.

Porous Pavement. A hard surface that can support some vehicular activities, such as parking and light traffic, and which can also allow significant amounts of water to pass through.

Pretreatment. The treatment of industrial wastewater to remove contaminants prior to discharge into municipal sewage systems.

Primary Treatment. A wastewater treatment method that uses settling, skimming, and (usually) chlorination to remove solids, floating materials, and pathogens from wastewater. Primary treatment typically removes about 35 percent of BOD and less than half of the metals and toxic organic substances.

Publicly Owned Treatment Works (POTW). Any sewage treatment system operated by a public agency.

Pumpout. The process through which septage is removed from a septic tank or boat holding tank, usually by a mobile tank attached to a truck, and taken to a wastewater treatment plant for disposal.

Request for Determination of Applicability. A written request made by any person to a conservation commission or to the Department of Environmental Protection for a determination as to whether a site or work on that site is subject to the Wetlands Protection Act.

Runoff. The part of precipitation that travels overland and appears in surface streams or other receiving water bodies.

Salt Marsh. A costal wetland that extends landward up to the highest high tide line (i.e., the highest spring tide of the year) and is characterized by plants that are well adapted to living in saline soils.

Secondary Treatment. A wastewater treatment method that usually involves the addition of biological treatment to the settling, skimming, and disinfection provided by primary treatment. Secondary treatment may remove up to 90 percent of BOD and significantly more metals and toxic organics than primary treatment.

Septage. That material removed from any part of an individual sewage disposal system.

Septic System. A facility used for the partial treatment and disposal of sanitary wastewater, generated by individual homes or small businesses, into the ground. The system includes both a septic tank and a leaching facility.

Septic Tank. A watertight receptacle that receives the discharge of sewage from a building sewer and is designed and constructed so as to permit the retention of scum and sludge, digestion of the organic matter, and discharge of the liquid portion to a leaching facility.

Sewage. The water-carried human or animal wastes from residences, buildings, industrial establishments or other places, together with such ground water infiltration and surface water as may be present.

Sewer System. Pipelines or conduits, pumping stations, force mains, and all other structures, devices, appurtenances, and facilities used for collecting and conveying wastes to a site or works for treatment or disposal.

Shellfish. An aquatic animal, such as a mollusc (clams and snails) or crustacean (crabs and shrimp), having a shell or shell-like exoskeleton.

Shellfish Bed. An area identified and designated by the Division of Marine Fisheries or conservation commissions as containing productive shellfish resources. Shellfish bed maps are based upon written documentation and field observations by the shellfish constable or other authoritative sources. In identifying such an area, the following factors shall be taken into account and documented: the density of all species of shellfish, the size of the area, and the historical and current importance of the area to recreational or commercial shellfishing. Protecting designated shellfish beds may be an important consideration when local boards and state agencies review projects.

Shellfish Resource Area. An area, designated by the Division of Marine Fisheries, that contains productive shellfish beds, and is used for establishing shellfish resource area closure boundaries.

Shellfish Resource Area Closures. Closure, due to potential health risks, of shellfish resource areas to shellfish harvesting. Closure decisions are made by the Division of Marine Fisheries, using a current standard that specifies that if the geometric mean of 15 samples equals or exceeds 14 fecal coliform per 100 milliliters of sample water or if 10% of the samples exceed 49 fecal coliform per 100 milliliters of sample water, the station can be closed. The five shellfish bed classifications are Approved, Conditionally Approved, Restricted, Conditionally Restricted, and Prohibited.

Sludge. Solid or semisolid material resulting from potable or industrial water supply treatment or sanitary or industrial wastewater treatment.

Soil Conservation Service (SCS). A branch of the U.S. Department of Agriculture that, among other things, provides technical assistance in resource management and planning and implemen-

tation of agricultural BMPs. SCS works closely with the Agricultural Stabilization and Conservation Service (ASCS) and County Extension Services to achieve their goals.

Spring Tides. Higher than normal high tides observed every two weeks when the earth and moon align.

Storm Drain. A system of gutters, pipes, or ditches used to carry stormwater from surrounding lands to streams, ponds, or Massachusetts Bays. In practice, storm drains carry a variety of substances such as oil and antifreeze which enter the system through runoff, deliberate dumping, or spills. This term also refers to the end of the pipe where the stormwater is discharged.

Stormwater. Precipitation that is often routed into drain systems in order to prevent flooding.

Subdivision. A means for dividing a large parcel of land into more than one buildable lot, administered under MGL Chapter 41.

Superseding Determination. A Determination of Applicability issued by the Department of Environmental Protection deciding whether or not the area and activity are subject to the regulations under the Wetlands Protection Act.

Superseding Order of Conditions. A document issued by the regional office of the Department of Environmental Protection containing the conditions necessary for a project to proceed and still protect the interests and resource areas specified in the Wetlands Protection Act. These conditions supersede Orders of Conditions set by the local conservation commission unless the local order is also issued under the authorization of a local bylaw. These superseding orders can be requested by a number of people who may not be satisfied with the local Order of Conditions.

Suspended Solids. Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles as well as organic solids in wastewater.

Swales. Vegetated areas used in place of curbs or paved gutters to transport stormwater runoff. They also can temporarily hold small quantities of runoff and allow it to infiltrate into the soil.

Tertiary Treatment. The wastewater treatment process that exceeds secondary treatment; could include nutrient or toxic removal.

Tidal Flat. Any nearly level part of the coastal beach, usually extending from the low water mark landward to the more steeply sloping seaward face of the coastal beach or separated from the beach by land under the ocean, as defined in 310 CMR 9:04.

Tidelands. All lands and waters between the high water mark and the seaward limit of the Commonwealth's jurisdiction, as defined in 310 CMR 9:04. Tidewaters are synonymous with tidelands.

Title 5. The state regulations (CMR 15) that establish minimum standards for the protection of public health and the environment when circumstances require the use of individual systems for the disposal of sanitary sewage. The local board of health is responsible for enforcement of these regulations.

Total Nitrogen. A measure of all forms of nitrogen (for example, nitrate, nitrite, ammonia-N, and organic forms) that are found in a water sample.

Toxic. Poisonous, carcinogenic, or otherwise directly harmful to life.

Wastewater. Water that has come into contact with pollutants as a result of human activities and is not used in a product, but is discharged as a waste stream.

Waterbirds. A group of birds that utilize wetland habitats during their life cycle, including waterfowl (ducks and geese), seabirds (terns and gulls), and wading birds (herons and egrets).

Water Column. The water in a lake, estuary, or ocean which extends from the bottom sediments to the water surface. The water column contains dissolved and particulate matter, and is the habitat for plankton, fish, and marine mammals.

Watercourse. Any natural or man-made stream, pond, lake, wetland, coastal wetland, swamp, or other body of water. This includes wet meadows, marshes, swamps, bogs, and areas where groundwater, flowing or standing surface water, or ice provide a significant part of the supporting substrate for a plant community for at least five months of the year, as defined in 310 CMR 15:01. Boards of Health can adopt the definition of wetlands in 310 CMR 10.0 or broader language in Title 5 as a "watercourse" in determining setbacks.

Wetlands. Habitats where the influence of surface water or groundwater has resulted in the development of plant or animal communities adapted to aquatic or intermittently wet conditions. Wetlands include tidal flats, shallow subtidal areas, swamps, marshes, wet meadows, bogs, and similar areas.

Wrack. Algae, plant and animal matter, and drift material (including solid wastes and other pollutants) that accumulate on beaches, usually at the high tide mark.

Zoning Bylaws. Local laws that designate areas of land for different uses at established densities. These bylaws require a two-thirds majority vote of town meeting or city council.

APPENDIX E. MASSACHUSETTS BAYS PROGRAM GRANTS 1991

Recognizing that many critical pollution problems in the Bays demand immediate attention, the Massachusetts Bays Program has developed and funded three "Action Now" grant programs:

- Bays Action Grants
- Action Plan Demonstration Projects
- Mini-Bays Grants

These programs focus limited financial resources in a hands-on efforts to help citizens, organizations, and municipal and city governments take early actions to address threats to coastal resources. All three of these programs have been active in 1991. The following appendix describes each program and provides a list of 1991 grant recipients.

Bays Action Grants

The Massachusetts Bays Program created the "Bays Action Grant" program to fund community-based coastal awareness projects. This program was conceived as a means to help mobilize organizations and individuals interested in promoting coastal protection by providing all, or a share, of the financial assistance needed to translate a variety of proposals into tangible projects or products.

Fifteen environmental projects were awarded a total of $9,383 in "Bays Action Grants" by the Massachusetts Bays Program in 1991. The winning projects were selected for their promise to help educate the public about the need for coastal pollution control, ranging from a solo sail around the world to a children's educational guide to the ecology of local tidepools.

The 1991 Bays Action Grants are as follows:

Cape Cod		
Cape Outdoor Discovery Scorton Creek, E. Sandwich	$250	Citizen water quality monitoring program
Centerville Elementary School	$370	Environmental awareness program for 75 second graders
Dennis-Yarmouth Regional High School Science Department	$879	Environmental study of Yarmouth's Mill Pond by 60 students
North Shore		
Jed Sneed (11-year-old Gloucester resident)	$182	To produce a children's guide to tidepools
Ipswich River Watershed Association	$1,000	To produce an Ipswich River macroinvertebrate booklet
Massachusetts Audubon: North Shore	$300	To expand its Ocean Discovery Coastal Environmental Education Initiative to Lynn's Bricket School
Boston		
Boston Voyages in Learning	$1,000	To being the "Voyages Pinkney Project," linking 10 teachers and 1,300 students to William Pinkney's around-the-world solo sail

Nick Haddad (Cambridge educator)	$500	To edit and reproduce 50 copies of his "Boston's Working Port" video
MIT Sea Grant College Program	$1,000	To inaugurate its "Sewage Stack" interactive computer program for elementary schools
Friends of Belle Isle Marsh	$500	To produce a self-guiding, interpretive trail brochure
South Shore		
Ten Quincy Elementary Schools	$1,000	To involve students with MWRA and local officials in an exploration of wastewater technology
Great Woods Environmental Network	$500	To offer computer modem-users a free data base on the Boston Harbor cleanup
Reay E. Sterling Middle School	$1,000	To involve 50 sixth graders in a study of Quincy's coastal waterfront and marshlands
Weymouth Waterfront Committee	$400	To produce an informational brochure on the functions of the Weymouth waterfront
Hull Conservation Commission	$500	To produce a brochure on recommended solutions to pollution and insect problems in Straits Pond

Action Plan Demonstration Projects

Action Plan Demonstration Projects are designed to demonstrate the effectiveness of selected clean-up strategies and improvements which can be achieved on a small scale, and to help define the time and resources required for basinwide implementation.

The Massachusetts Bays Program has selected and funded four Action Plan Demonstration Projects in 1991:

$33,000 to the North and South Rivers Watershed Association to maintain, upgrade, and monitor stormwater drainage systems discharging into the North River in Marshfield, Norwell, Hanover, and Pembroke.

Although the North River in Massachusetts is classified SA water quality for most of its 12 miles, increasingly the shellfish beds near the mouth of the river are closed due to pathogen contamination. During rainstorms, most of the drainage pipes directly entering the river or tributaries have been shown to contain relatively high concentrations of fecal coliform bacteria. In addition, surveys have shown a high proportion of catch basins with sumps filled with sand and debris, and in some cases with pipes inappropriately discharging into the catch basins from unidentified sources.

The objectives of this project in the North River watershed are to:

- Provide proper monitoring and maintenance of the existing storm drain systems
- Remove illicit or inappropriate connections to the system
- Replace key inadequate catch basins with leaching structures

Funds requested would allow cleaning and structural improvements for five catch basins and purchase of monitoring equipment for an existing volunteer monitoring program.

$15,000 to the Town of Barnstable to monitor the effectiveness of a stormwater infiltration system to be installed at the parking lot area and boat ramp at Scudder Lane, an important shellfish relay area in Cape Cod Bay.

Receiving water samples taken and analyzed by the Town of Barnstable have shown that stormwater has a large impact on receiving water quality. Bacterial standards are frequently exceeded after a rainstorm event, causing closure of shellfish beds.

The objective of the project is to install and monitor the effectiveness of a stormwater infiltration system at the Scudder Lane site, a small recreational area with a parking lot and boat ramp. The system will be monitored for its effect on bacterial loads and heavy metals in the receiving groundwater and water column overlying shellfish beds. In addition, the stormwater will be monitored before and after sediment removal tanks to determine their effectiveness in removing sediment. The funds would allow the Town to:

- Install four monitoring wells and two observation points into the infiltration system
- Purchase laboratory materials for analysis, an automatic sampler with flow meter, and a Teflon bailer

$16,000 to the City of Gloucester Board of Health to expand a dye-testing program to control direct sewage discharges from inadequate septic systems.

In February 1990, the Gloucester Office of the Board of Health, in conjunction with the Shellfish Officer, designed a formalized plan of action leading to the elimination of direct sewage discharge from antiquated subsurface sewage disposal systems to local shellfish areas of various water-courses in Gloucester. This problem is extreme in the city because the majority of systems serving dwellings are located within 200 feet of coastal waters and are of an archaic design. The problem is compounded by a lack of municipal sewage availability to serve these dwellings. A goal of the local board of health is to eliminate direct discharges through identification by dye testing, water analysis, and enforcement. To date, 34 direct discharges have been eliminated; as a result, some shellfish harvesting areas have been reopened.

Funding is requested to expand the present dye testing program and purchase a computer and software in order to compile a data base including parameters regarding septic tank pumping and a GIS link.

$35,000 to the City of Quincy for the installation of a new tidegate to control tidal influx into the stormwater system.

This project is designed to address high levels of pathogen contamination in the nearshore waters of Quincy Bay. The proposed project has two objectives:

- Reduce bacterial contamination and resultant adverse impacts in Quincy Bay by installing or repairing stormwater drainage systems
- Assess the feasibility of an alternative to management of recreational beach and shellfish harvesting areas which is forward-looking rather than retrospective, and which does not rely primarily on bacterial examination (i.e., review system design alternatives and monitor before and after system modifications).

Funds are sought to support tidegate improvements at the Milton Road/Colby Street location to prevent tidal influx into the storm sewer system, an identified source of pathogens to nearby waters, and to prepare a report which will express and translate the Quincy Program experience basin-wide.

Mini-Bays Grants

The Mini-Bays program was established by the Massachusetts Bays Program to address land use issues and their impact on water quality at the embayment level. The program is designed to deal with specific problems in embayments, and implement projects that reduce pollutant loadings and/or improve habitat. Mini-Bays projects will promote innovative technologies or strategies

and are intended to be replicable Bays-wide. Funding for the projects will be shared by the Massachusetts Bays Program and local sources. Three embayments have been selected in the Massachusetts Bays area to carry out research, planning, implementation, monitoring, and pubic outreach efforts over five years, culminating in the production of an embayment management plan in 1995. The Mini-Bays grant recipients are:

- Plum Island Sound in Ipswich, Newbury, and Rowley
- The Fore River Embayment in Braintree, Weymouth, and Quincy
- Wellfleet Harbor in the Town of Wellfleet

The recipients were selected from a total of 17 applicants through a highly competitive process. Criteria for selection included: clear identification of pollution-related problems; evidence of a regionally cooperative effort to address those problems; and broad public interest and support. Also considered were: local and regional financial or in-kind service contribution; likelihood of the lessons learned being replicated region-wide; and likelihood of a measurable and sustainable improvement in water quality. The program will provide approximately $200,000 to $250,000 over five years to each of the emabyments selected. A description of each embayment project is provided below.

Plum Island Sound

The proposed study area, the Plum Island Sound/Rivers ecosystem, is defined as the tidal portions of the Plum Island Sound, including the Ipswich, Eagle Hill, Rowley, Parker, and Plum Island Rivers. This ecosystem has long been recognized as one of the most pristine and valuable estuarine habitats in the Northeast and as an area of regional and statewide significance. In recognition of this, the site was included in the Parker River/Essex Bay ACEC in 1979, the first coastal ACEC so recognized. Renowned for its shellfish, fisheries, recreational, and wildlife resources, the area is increasingly threatened by nonpoint and point source pollution, in addition to wildlife habitat losses. Increases in fecal bacterial levels and shellfish bed and swimming beach closures, coupled with decreases in anadromous fish populations, are evidence of growing environmental degradation.

The overall goals of the proposal are to develop, implement, and monitor a research/policy/education plan designed to reduce nonpoint and point source pollution of the Plum Island Sound/Rivers ecosystem. In addition, the research team will focus on and propose recommendations to protect and monitor the region's unique coastal habitats.

The project will be undertaken by the Massachusetts Audubon Society, in collaboration with Applied Sciences Associates, Inc. and the Towns of Newbury, Rowley, and Ipswich.

Fore River Embayment

Tri-community planners representing the municipalities of Braintree, Quincy, and Weymouth, with management assistance from the Tellus Institute, a non-profit environmental research organization, will coordinate a research program directed at the Fore River Embayment.

The Fore River Embayment is approximately a five-square-mile estuary bordered by the communities of Braintree, Quincy, and Weymouth. The water quality classification of the river is SB, which means the Fore River is designated for protection and propagation of fish, other aquatic organisms, primary and secondary contact recreation, and shellfish harvesting. Because of shoaling conditions, coupled with historic filling and development, the US Army Corps of Engineers has determined that the future use of the Fore River for boating and recreation is contingent upon channel dredging.

The embayment contains substantial coastal wetlands. While their environmental integrity has been significantly compromised, these wetlands continue to serve as important fishery and wild-

life habitat. Shellfish beds totaling about 220 acres exist, but none of these beds has been used on an unrestricted basis since the 1970s. Although virtually no commercial fisheries remain in the embayment, the area remains a popular sport fishery.

At various times in the embayment's past, the Fore River has been home to a major shipyard, oil refinery, petroleum storage facility, hazardous waste processing facility, and power generating facilities. In addition, the embayment will soon be home to the MWRA's sludge processing facility, as well as the new Boston Edison Edgar Station. Much of the growth on the Fore River has occurred without forethought or consideration of the cumulative environmental consequences, and without effective coordination among the communities. As a consequence, the environmental quality within the Fore River has declined to a point where the embayment's beaches are often closed by contamination in order to protect public health.

While Braintree, Quincy, and Weymouth recognize that the Fore River's environment has been damaged by urbanization and industrial development, no attempt has been made to systematically document and understand the environmental health of the embayment in an integrated manner. More importantly, no attempt has been made to mitigate these impacts and comprehensively manage the embayment in order to protect it from further degradation and possibly restore some of its previous uses.

The objective of this proposal is to initiate a tri-community effort to end the piecemeal management of the embayment and begin to measurably improve environmental conditions. This project will begin to forge the institutional mechanism required for better understanding and management of the embayment. Further, the group will identify one or more critical environmental problems which can be measurably improved within the time frame and resources of the Mini-Bays program.

Wellfleet Harbor

While the primary focus is on Wellfleet Harbor and associated subembayments, additional work will involve the Harbor's watershed. The Harbor itself boasts a variety of commercial and recreational activities accommodating over 500 recreational and commercial vessels. The Harbor is one of the state's most important aquaculture sites containing one third of the state's total shellfish grants. Designated an ACEC in 1988, the Harbor and areas extending to Gulf Pond support a major finfish nursery.

Although water quality within Wellfleet Harbor is generally good, increasing signs of environmental degradation have been noted, including shellfish bed closures, the disappearance of eelgrass beds, and the increasing occurrence of nuisance algae. This may not be altogether surprising as Wellfleet has experienced a 43% growth in population during the past two decades.

The overall objective of the proposed work is to formulate and implement a comprehensive conservation and management plan for Wellfleet Harbor and its watershed. This would help to protect the marine resources of Wellfleet Harbor from further degradation, protect the public from exposure to human pathogens originating from on-site sewage disposal systems or marine sanitary wastes, and increase the acreage open to shellfishing within the harbor. In order to achieve these first two goals, the initial phase of the project will characterize the present state of the harbor and compare this with past studies. Extensive inventorying will be conducted and water chemistry monitored. Alterations in land use and growth within the harbor watershed will be documented and these changes related to observed changes in resources. This will be accomplished by researching the historical record, coupled with aerial photography. Detailed maps displaying resource and critical habitat areas may then be developed.

The project will be undertaken by the Town of Wellfleet, the Barnstable County Health and Environmental Department (BCHED), the County Cooperative Extension (CCE), and the Water Resources Office of the Cape Cod Commission.